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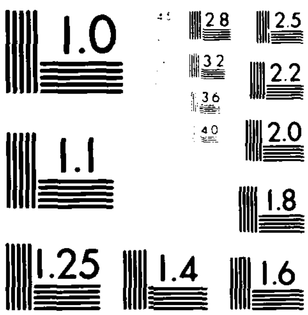

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS

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AMRL-TR-78-125

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DEVELOPMENT OF NOISECHECK TECHNOLOGY FOR MEASURING AIRCRAFT NOISE EXPOSURE

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MAY 1980

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FOR THE COMMANDER

Henning E. von Gierke

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Director
Biodynamics and Bioengineering Division
Aerospace Medical Research Laboratory

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This report describes a program to develop instrumentation for use by Air Force personnel to make spot checks of the noise exposure at locations in and about air bases. These instruments combined with standardized field measurement procedures form a technology, termed NOISECHECK, which provides a means for measuring the noise environment and checking daily average noise level values (DNL's) calculated by the Air Force NOISEMAP community-aircraft noise prediction program.

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After analysis of measurement requirements and a survey of available equipment, four prototype portable noise level monitoring systems were acquired. The principle components were an electret type microphone and a microprocessor based noise level monitor unit with alpha-numeric printout suitable for use by minimally trained personnel. The systems were ~~utilized~~ used in a field measurement demonstration test conducted at Barksdale AFB in June 1978. In this three-week field program, aircraft noise levels and operational data were acquired and analyzed in detail. to develop and evaluate NOISECHECK procedures for test planning, test conduct, and data analysis.

The data analysis included determination of yearly average DNL values by several methods of varying complexity and assessment of statistical confidence intervals for the different methods. Differences between measurements and predictions were traced to incorrect inputs to NOISEMAP describing heavy aircraft operations at Barksdale AFB.

The detailed NOISECHECK procedures are provided in a separate document.

SUMMARY

This report describes a program to develop instrumentation for use by Air Force personnel to make spot checks of the noise exposure at locations in and about air bases. These instruments combined with standardized field measurement procedures form a technology, termed NOISECHECK, which provides a means for measuring the noise environment and checking daily average noise level values (DNL's) calculated by the Air Force NOISEMAP community-aircraft noise prediction program.

After analysis of measurement requirements and a survey of available equipment, four prototype portable noise level monitoring systems were acquired. The principle components were an electret type microphone and a microprocessor based noise level monitor unit with alpha-numeric printout suitable for use by minimally trained personnel. The systems were utilized in a field measurement demonstration test conducted at Barksdale AFB in June 1978. In this three-week field program, aircraft noise levels and operational data were acquired and analyzed in detail to develop and evaluate NOISECHECK procedures for test planning, test conduct, and data analysis.

The data analysis included determination of yearly average DNL values by several methods of varying complexity and assessment of statistical confidence intervals for the different methods. Differences between measurements and predictions were traced to incorrect inputs to NOISEMAP describing heavy aircraft operations at Barksdale AFB.

The detailed NOISECHECK procedures are provided in a separate document.

PREFACE

This research program was performed for the Aerospace Medical Research Laboratory at Wright-Patterson Air Force Base, Ohio under Project/Task 723107, Technology to Define and Assess Environmental Quality of Noise From Air Force Operations. Technical monitor for this effort was Mr. Jerry Speakman of the Biodynamics Environment Branch, Biodynamics and Bioengineering Division, Aerospace Medical Research Laboratory.

The contributions of a number of individuals, in particular Dwight Bishop, David Conant and John Mills are gratefully acknowledged.

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INTRODUCTION

PURPOSE AND SCOPE

The purpose of this project is to develop standardized noise measurement equipment and procedures for making spot checks of the noise exposure at ground locations in and about Air Force air bases. The equipment and procedures, termed NOISECHECK technology, is to be used by Air Force personnel to measure the noise environment and check the noise exposure values calculated by the Air Force NOISEMAP community-aircraft noise exposure prediction program.[1]

The scope of the project included the selection and procurement of four prototype portable noise level monitoring systems, and the development of detailed procedures for performing field measurements. The procedures involve test planning, data acquisition and use of measured data to make yearly average day-night noise level* (DNL) estimates of predictable accuracy. The procedures are presented as a separate document.[2]

The project consisted of the following tasks"

- State-of-the-Art Survey
- Equipment Selection
- Field Test
- Data Analysis
- Critique
- Safety Study
- Development of Measurement Procedures

* Day-night noise level is defined as the A-weighted sound level averaged on a power basis over 24 hours with a plus 10 dB weighting applied between 2200 and 0700 hours.

BACKGROUND

The USAF has recognized that its airbases and adjacent civilian communities must co-exist. In order to protect these adjacent communities from the noise and safety hazards associated with aircraft operations and preserve the operational integrity of the airfields, the USAF has developed and implemented the Air Installation Compatible Use Zone (AICUZ) concept. An AICUZ for an airfield is generated from the composite application of accident potential zones (APZs) and Noise Zones (NZs). The Noise Zones are based on predicted day/night average sound level (DNL) contours. These contours are estimated from airfield operational statistics, the noise generation characteristics of the aircraft involved, (NOISEFILE), and physical noise transmission relations embodied in NOISEMAP.

However, the contour estimates may be subject to error because of incorrect aircraft operational input data, incorrect aircraft noise data, or local acoustic phenomena not accurately represented in NOISEMAP. Often, to resolve controversy or as an aid in litigation, field measurements of a site DNL are desired.

REPORT ORGANIZATION

Section 2 presents the results of the state-of-the-art survey and equipment selection. The results of the system safety program are presented in Section 3. Section 4 summarizes the field test measurement program which was conducted at Barksdale AFB. Conclusions and recommendations are set forth in Section 5. A detailed description of the field measurement program and the analysis of field data is presented in the Appendix.

STATE-OF-THE-ART SURVEY AND EQUIPMENT SELECTION

Early in the program, a survey was performed to document the state-of-the-art in the measurement of aircraft generated noise levels. The survey was divided into two aspects, methodologies employed and equipment available. The methodologies survey was based on experience of measurement programs performed at both military and civilian airports. The equipment survey was based mainly on manufacturer's specification data and interviews with users.

FIELD MEASUREMENT METHODS

Fourteen different measurement programs performed at either military or civil airports were reviewed. A summary of pertinent program characteristics is given in Table 1. In the category of information available, the types of aircraft, the yearly flight statistics, and the flight paths were known beforehand for all military airbase surveys. NOISEMAP predictions, previous site measurements, radar flight tracks, and performance profiles were available for approximately one-half of the military airbase surveys.

Again referring to Table 1, the type of aircraft operations producing the noise at the sites in question were equally divided between takeoffs and landings with some pattern flying and infrequent ground run-ups. The locations of the measurement sites were usually adjacent to the transition portions of the flight paths.

The categories of close-in, intermediate, and extended are generally related to the position of the aircraft from brake release or landing threshold. The definitions of the categories are as follows:

Takeoff Operations

- Close-in (0 to 2 miles from brake release)
- Intermediate (1.5 to 4 miles from brake release)
- Extended (3 to 10+ miles from brake release)

Approach Operations

- Close-in (landing roll to 1 mile from landing threshold)
- Intermediate (1 to 4 miles from landing threshold)
- Extended (3 to 10 miles from landing threshold)

The average number of measurement locations for the programs reviewed was ten. On the large programs, especially at Miramar NAS[3], the units were moved from site-to-site so that the maximum number of units in the field at any one time never exceeded six for any programs listed.

TABLE I - FIELD MEASUREMENT PROGRAM
CHARACTERISTICS SURVEY SUMMARY *

Field Measurement Program Characteristic	Military									Civilian					Total or Avg.
	Barksdale AFB,76	England AFB,76	Travis AFB, 76	Lemore NAS, 72	Fallon NAS, 72	El Toro NAS,71	El Toro NAS,77	March AFB, 70	Miramar NAS 77	Anchorage, 72	Stockton, 76	San Diego, 77	Burbank, 77	Roanoke, 77	
Information Avail. Beforehand															
NOISEMAP	x	x	x						x			x			5
Site Measurement							x		x						2
Types of A/C	x	x	x	x	x	x	x	x	x	x	x	x	x	x	14
Yearly Flight Statistics	x	x	x	x	x	x	x	x	x			x			10
Flight Paths	x	x	x	x	x	x	x	x	x	x	x	x	x	x	14
Radar Flight Tracks	x	x	x				x		x	x	x	x	x	x	10
Alt. and Power Profiles	x	x	x						x				x	x	6
Aircraft Operations															
Ground Run-Up				x					x						2
Takeoff-Close -In		x							x				x		3
Intermediate		x		x	x	x	x	x	x	x	x	x	x	x	12
Extended									x						1
Pattern Flying	x			x	x			x	x						5
Landing-Close -In			x						x					x	3
Intermediate			x	x	x	x		x	x	x	x	x	x	x	11
Extended									x						1
Accuracy, 90% Confidence, ± dB	1	1	1						2.5						
Instrument Used															
SLM	x	x	x			x		x	x						6
White box (BBN 704)	x	x	x	x	x		x		x	x	x	x	x	x	12
Silver box (BBN 614)							x		x		x	x	x	x	6
How many sites	3	3	4	12	6	5	7	4	46	6	13	10	10	8	10 Avg.
Stanchions at Sites	1	2	1	4	6	3	3	-	2	3	3	0	0	2	0.3 Avg
Security Fences or Homes	2	1	3	2	0	0	2	-	26	3	3	10	10	6	0.4 Avg
Measurements (Primary type underlined) SEL	x	x	x	x	x	x	x	x	x	x	x	x	x	x	14
HNL	x	x	x	x	x		x		x	x	x	x	x	x	12
DNL (CNEL)	x	x	x										x		3
Duration Weeks	2½	2½	2½	2	2	1	2	1	16	2	2	2	2	2	2+
Data Corrections															
Number of A/C	x	x	x	x	x	x	x	x	x	x	x	x	x	x	14
Types of A/C	x	x	x							x	x	x	x	x	8
Flight Tracks	x	x	x												3
Temp/Humidity	Bounds														Bounds
Site Extrapolation							x		x				x	x	4
Contour Line				x	x	x	x	x	x	x	x	x	x	x	11

* References 3 - 14.

Protection of the portable noise level monitor systems from vandalism was a constant problem for most of the field measurement programs listed. One unit was stolen during the Miramar study[3]. Suitable stanchions for chaining the units to homes or fences were available approximately 30 percent and 40 percent of the time, respectively.

The average duration of the measurement programs was slightly in excess of two weeks with only one of long duration (16 weeks).

Portable noise level monitor units were employed on all but two of the field measurement programs listed in Table 1. The measurements performed on-site included DNL, HNL and individual aircraft SEL. Most of the measurement programs used the measured SEL values to arrive at the desired expression of daily noise level.

With regard to data analysis, corrections were applied to all measured values for the number of aircraft. One-half of the programs separated the aircraft by types to arrive at corrections. The only field measurement programs which did not result in noise contour line verification were those performed to validate aspects of NOISEMAP[4].

Confidence intervals were computed for only the program at Miramar NAS[3]. The ± 2.5 dB interval indicated is considered conservative in that instrumentation variability was added to measured HNL variability in the computation of confidence intervals. This method is conservative because some of the instrumentation variability is naturally included in the HNL variability. Generally, confidence intervals were not stated for the other 13 measurement programs either because a commonly accepted methodology for combining sources of uncertainty was not available or because there were no requirements for specifying the confidence intervals.

MEASUREMENT VARIABILITY

In order to plan efficient test programs a'priori estimates of the inherent variability in single events and day-night levels are desired. The results from various data sources, including the Barksdale AFB field test performed as part of this program, show that the variability of single events and day-night levels is essentially independent of distance, Table 2. This trend was verified by the Barksdale AFB test results which showed similar SEL variability for all sites. However, the magnitude of the single site variability values was much greater at Barksdale than for previous programs, even though the SEL's were segregated by type of operation as well as type of aircraft.

Note that 6 dB is the average arithmetic standard deviation of sets SEL values. Some standard deviations were as small as 1.0 dB, usually for straight in approaches of heavy aircraft.

An explanation for the large average SEL variability at Barksdale is that the aircraft are flown with greater variety of flight profiles than previously experienced. This can be attributed to the preponderance of practice flying at Barksdale. Measurement of slant distances and normalization of measured SEL values would have provided a better understanding of the sources of variability but this is not a primary purpose of a site DNL verification field test.

Fortunately, the variability of SEL's is not critical to overall measurement accuracy because their contribution to overall uncertainty decreases as the square root of the number of samples (and numerous single event samples are easily obtainable).

TABLE 2

MEASUREMENT STANDARD DEVIATIONS, ± dB

		Type Airport		
Type Measurment	Aircraft	Civilian	Military	Barksdale*
Single Site SEL	Same	3.2	1.5	6
Single Site SEL	Different	3.4	5.3	12
Single Site DNL	Different	2.3	3.4	3.0

* Measurements reported in the Appendix.

The DNL variability at civilian airfields was found to be less than for military airfields. The Barksdale DNL variability results matched previous experience.

MICROPHONE CHARACTERISTICS AND SELECTION

The important microphone characteristics were determined by combining a literature and users survey with the results of an analysis of the NOISECHECK scenarios*. These important characteristics are as follows:

Frequency response

Directivity

Humidity resistance

Sensitivity stability

Ruggedness

Power Consumption

Accurate measurement of signals between 5000 and 10,000 Hz was considered important since some aircraft radiate significant acoustic energy about 5000 Hz.

The frequency response of a microphone depends mainly on two factors, size and damping. As the diameter of the microphone approaches an acoustic wavelength, the average pressure of a grazing wave across the diaphragm goes to zero. For this reason, only one-half inch microphones were considered for NOISECHECK since the wavelength at 10,000 Hz is only slightly greater than one inch.

Damping controls the pressure-to-deflection frequency response function for a given microphone configuration. Damping may be chosen so as to compensate for the pressure increase effects for a normal incident sound wave. Microphones with

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* The analysis of the NOISECHECK scenarios was part of the system safety program.

this degree of damping are called normal incidence microphones. Other microphones with less damping have flat frequency response for sound waves arriving at approximately 60° from normal incidence. These are referred to as "random incidence" or "pressure" type microphones.

For aircraft noise measurements, it is usually possible to point the microphone at the aircraft. Therefore, normal incidence type microphones were seriously considered. However, aircraft noise measurements are also usually performed with windscreens over the microphone. The windscreen serves to prevent wind gusts from reaching the microphone diaphragm which cause low frequency pressure fluctuations (which are not noise). The windscreen also serves to collect rain, keeping moisture from the microphone. For this second purpose, a dense, sponge-like windscreen is desirable. To satisfy this requirement, commercially available acoustic windscreens and four inch diameter Nerf balls were investigated and found to produce a high frequency roll-off which inversely matched the pressure increase effect of an incident wave giving a net flat frequency response, Figure 1. Unfortunately, the Nerf ball, and to a lesser extent, four inch diameter acoustic windscreens, exhibit a slight (1 dB) hump in the frequency response between 1,000 and 2,000 Hz. This has been hypothesized to be due to a one-quarter wave resonance in the windscreen. With the mid-frequency hump in mind, the flat pressure response type microphone along with a dense sponge-like windscreen was the combination selected for NOISECHECK.

The specification characteristics of specific microphones which are both commercially available and suitable for field measurements are presented in Table 3. Some of the microphones are known to have been used for field measurements, others are included for completeness. After eliminating one-inch microphones and 0° incidence microphones, the final choice was between the GEN/RAD Model 1962-9601 and the B&K Model 4166 microphones. The use of a quartz sealed diaphragm with a dessicant accessory was recommended in a National Bureau of Standards study[15].

However, the long term stability and humidity resistance of the air condenser microphone was not considered as important as the ruggedness and absence of polarization voltage of the

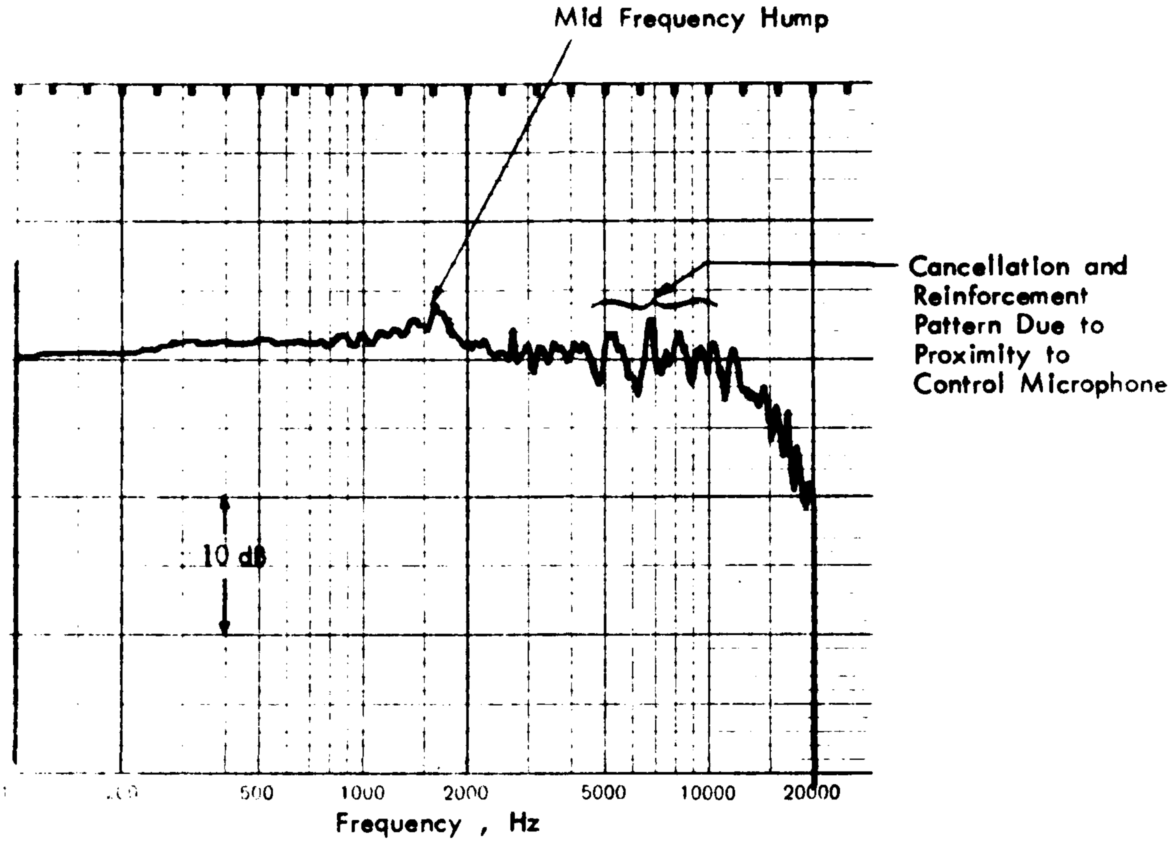


FIGURE 1. RESPONSE OF AN ELECTRET RANDOM INCIDENCE MICROPHONE WITH A FOUR INCH DIAMETER NERF BALL WINDSCREEN

TABLE 3. COMPARISON OF MICROPHONE CHARACTERISTICS FOR NOISECHECK

MFG	MODEL	TYPE (RANDOM INCID. UNLESS NOTED)	SIZE	CLASS	SEN*	POL VOLT	DYN** RANGE	FREQ. RESP.	CAPAC. Pf	TEMP. EFFECT CAP. Pf/°C	TEMP. EFFECT SENS. dB/°C	VIB. SENS, dB re 20μN/mg
GEN/RAD	1962-9601	Electret	1/2	I	-41	---	26-145	5-19K	35	<+0.1	<±0.02	83
B&K	4149	Air Cap, Back Vent Anti Corros(0°Incid)	1/2	I	-38	200	160	4-40K	18	N/S	0.01	88
B&K	4165	Air Cap, Back Vent Quartz (0°Incidence)	1/2	I	-26 -38	200 50	146	3-20K	19	N/S	0.001	80
B&K	4134	Air Cap Standard	1/2	I	-38	200	160	4-20K	18	N/S	0.01	88
B&K	4125	Air Cap, Dosimeter (0° Incidence)	1/2		-40	28	146	7-6.3K	14.5	N/S	-0.02	85
B&K	4166	Air Cap, Back Vent Quartz	1/2	I	-26 -38	200 50	146	3-9K	20	N/S	0.001	80
GEN/RAD	1971-9601	Piezoelectric	1	II	-40	---	22-145	5-10K	385	2.2	-0.01	N/S
B&K	4117	Piezoelectric	1	II	-50	---	140	3-10K	4nf	N/S	-0.015	120
BBN	379	Hydrophone	0.63x1.5 +5/16x4.5	II	-66	---	40-170	20-12K	160	N/S	-0.005	N/S

*dB re v/Pa
**dB re 20μN/m²

electret microphone. The dominant factor is that for NOISECHECK, the units will be recalibrated frequently and long term environmental effects are, therefore, not important.

PREAMPLIFIERS AND ACCESSORIES

Commercially available preamplifiers and accessories suitable for NOISECHECK are listed in Tables 4 and 5, respectively. The main differences between the preamplifiers are the type of microphone fitting and whether or not polarization voltage is supplied. With the selection of an electret type microphone, the standard 0.46-60 microphone fitting was required, no polarization voltage was necessary, and the GR Model 1972-9600 preamplifier was selected. The power consumption for this unit is lower than for any other preamplifier listed, which is due in part to absence of polarization voltage.

Accessories chosen were the GEN/RAD Model 1567-9701 calibrator, Nerf ball windscreens, and commonly available tripods. For shipping cases, inexpensive suitcases were lined with polyurethane foam to the shape of the noise monitors. Accessory cases were similarly lined for carrying battery, tripod, microphones, preamplifier, cable, and locking chain.

PORTABLE NOISE LEVEL MONITOR UNITS

Fourteen prospective vendors were contacted in order to develop a definition of the state-of-the-art in portable noise level monitoring. As a result of their replies, in-house experience and a recognition of desirable attributes for NOISECHECK summarized in Table 6, general specifications were developed. These are listed in Table 7.

As a result of the cost specification and operational analyses, only the BBN Model 614 and DAI 607P are considered acceptable. Table 8 compares the two units in detail; the major areas of difference are as follows:

TABLE 4. COMPARISON OF PREAMPLIFIER CHARACTERISTICS FOR NOISECHECK

MFG.	MODEL	SIZE IN		FREQ.RESP. ($\pm$ 1 dB) Hz.	IMPEDENCE				CONNECTOR		POL VOLT	POWER	
		DIA.	LEN.		INPUT		OUTPUT		MIC	OUTPUT		VOLT	Ma
					Ω	Pf	Ω	μf					
GEN/ RAD	1972-9600	1/2-3/4	3.44	5 - 100K	1G	3	20	6.8	0.46-60	A3M*	None	9	1
GEN/ RAD	1960-P40	1.56	6.88	5 - 500K	500 K	6	20	3.3	A3M	A3M	None	20	1.5
GEN/ RAD	1960-P42	1/2	6.75	5 - 500K	2G	6	15	3.3	0.46-60	Cable, 10'BNC	200	20	4
B&K	2619	1/2	3.25	2 - 200K	7G	1	7		0.46-60	Cable, 2m, B&K	200	28	0.5
B&K	2642	1/2	2.1	20 - 20K	1G	3	1.6 K		0.46-60	JP0406 2m Cable	Cary thru	30	

* For use with piezelectric type microphone

* Switchcraft

TABLE 5. COMPARISON OF ACCESSORIES CHARACTERISTICS FOR NOISECHECK

FUNCTION	MFG.	MODEL	SIZE MIC	SIZE LEN	SIZE DIA	PERFORMANCE	WEIGHT LB
Dehumidifier	B&K	UA0308	1/2	2	1/2	-	-
Calibrator	GEN/RAD	1567-9701	1/2	4.4	2.4	1000 Hz, 114 dB	1
	GEN/RAD	1562-A	1/2	5	2.3	125,500,1K,2K,4K, 124 dB	1
	B&K	4230	1/2	4.4	1.6	1000 Hz, 94 dB	0.57
	B&K	4220	1/2	8.7	1.4	250 Hz, 124 dB	1.5
Windscreen	B&K	UA0381	1/2	-	4	Birdspikes	-
	B&K	UA0237	1/2	-	4	-	-
	B&K	UA0459	1/2	-	2.5	-	-
	GEN/RAD	1560-9522	1/2	-	4	-	-
Weatherproof System	GEN/RAD	1945-9730	1/2	12	3.1	Birdspike,pre amp	-
Tripod	BBN	802	-		-	-	-
	GEN/RAD	1560-9590	-		-	-	-
	B&K	UA0049	-		-	-	-

TABLE 6

ATTRIBUTES OF PORTABLE NOISE LEVEL MONITOR

INPUT

- Uncomplicated command sequence designed for untrained or infrequent operator
- Tactile feedback keyboard
- Bright lighted digital display of command before entry

OUTPUT

- Alpha-numeric paper tape record
- Bright lighted digital display presenting information for all three types of commands (set, read, and print) plus error codes
- Machine status printout

MECHANICAL

- Balanced about carrying handle
- Accessable, quick disconnect batteries
- Separate microphone and accessories connectors
- Weatherproof connectors
- Three switches (power, weighting, response) all normally to the right

TABLE 7

GENERAL SPECIFICATIONS FOR PORTABLE NOISE LEVEL MONITORS

	Description	Specification
Mechanical		
	Weight with Batteries	$\leq$ 50 lb
	Batteries	
	Removable	Yes
	Rechargeable	Desirable
	Life HNL Mode	3 Days
	SEL Mode	1 day,250 events
	Rain Proof	Yes
	Power for Preamplifier	15-25 VdC
	(Desirable)	5 Ma
	Security Lock	Yes
Function	Frequency Weighting	
	Linear	Desirable
	A	Yes
	D	Optional
	Detection	True RMS
	Time Constant	Slow ANSI S1.4-1971
	Sampling Period	$\leq$ 0.5 sec.
	Clock Accuracy	$\pm$ 10 sec/day
	Computations	
	LEQ (Selectable time)	Desirable
	HNL	Yes
	SEL (Threshold adjustable)	Yes
	L_{MAX} for SEL	Yes

TABLE 7 (CONT)

GENERAL SPECIFICATIONS FOR PORTABLE NOISE LEVEL MONITORS

	Description	Specification
Input	Impedance	> 10 KΩ
	Source Impedance	< 70 Ω
	Noise Floor "A" Weighting with Source Impendance	- 100 dBV
	Dynamic Range	
	Automatic	80 dB
	Manual	100 dB
Output		
	Integral Printer	Yes
	Sound Level Range	30 - 130 dB re: 20μ N/M^2
	Resolution	$\leq$ 0.5 dB
	Time Printed with	
	LEQ	Yes
	HNL	Yes
	LDN	Yes
	SEL	Yes

Table 8 - Specification Parameter Comparison for Portable Statistical Noise Level Monitor

Input Parameter	Units	NOISECHECK Requirement	Candidate Units: BBN 614	Candidate Units: DAI 607P
Input Impedance	KΩ	Greater than 10	121	60
Source Impedance	Ω	No more than 70	NMT 4000	N/S*
Noise Floor, (A) WTD, with Source Impedance	dBV	-100	-100	≥-100
Dynamic Range				
Automatic	dB	80	100	≥100
Manual	dB	100	N/A	N/A
Voltage Range	dBV	-	-110 to 10	-100 to 0
Crest Factor	dB	-	10	7

* N/S - Not Specified

Table 8 - Specification Parameter Comparison for Portable Statistical Noise Level Monitor (Continued)

Function Parameter	Units	NOISECHECK Requirement	Candidate Units BBN 614	Candidate Units DAI 607P
Frequency Weighting	LIN	Desirable	Option	Yes
	A	Yes	Yes	Yes
	D	Option	Not Yet	Option
Detection	Type	True rms	True rms	True rms
Time Constant	Type	Slow ANSI SI.4-1971	Slow	Slow/ Fast
Sampling Period	sec	Less than 0.5	0.5	0.125
Clock Accuracy	sec	Less than ±10 per day	<±10	<±10
Computations				
LEQ (select t)	-	Desirable	Yes	Yes
HNL		Yes	Yes	Yes
L_{dn}		Yes	Yes	Yes
SENEL		Yes	Yes	Yes
LMAX for SENEL		Yes	Yes	Yes

Table 8 - Specification Parameter Comparison for Portable Statistical Noise Level Monitor (Continued)

Output Parameter	Units	NOISECHECK Requirement	Candidate Units	
			BBN 614	DAI 607P
Integral Printer	-	Yes	Yes	Yes
Type	-	-	Impact	Thermal
Sound Level Range	dB re 20 μ N/m^2	30-130	30-130 or 38-138	30-130
Resolution	dB	Less than 0.5	0.2	0.1
Time Printed With LEQ	-	Yes	Yes	Yes
HNL	-	Yes	Yes	Yes
LDN	-	Yes	Yes	Yes
SENEL	-	Yes	Yes	Yes
LED Display	-	Desirable	No	Yes
Battery Meter	-	Desirable	Yes	Print-Out
Printer				
Columns	-	-	21	20
Characters	-	-	16	64
Rows	no/in	-	5	6

Table 8 - Specification Parameter Comparison for Portable Statistical Noise Level Monitor (Continued)

Mechanical Parameter	Units	NOISECHECK Requirement	Candidate Units BBN 614	Candidate Units DAI 607P
Weight Basic	lbs		18	N/S
with Batteries	lbs	Less than 50	44	<50
Size	ft^3		1.5	N/S
Batteries				
Removable	-	Yes	Yes	Yes
Rechargeable	-	Desirable	Yes	Yes
Life, HNL mode	Days	3	7	≥ 3
SENEL mode	Days	1	>1	≥ 1
	Events	250	>250	>250
Battery	Vdc		18	6
A/C Power		Desirable	Option	Option
Temp. Limits: Basic	°C	-10 to 55	-10 to 55	-10 to 55
Temp. Limits: Printer	°C	0 to 45	-10 to 55	0 to 45
Rain Proof		Yes	Yes	Yes
Preamplifier Power	Vdc	15-25 (Desirable)	17	Yes
	ma	5 (Desirable)	15	Yes
Security Lock		Yes	Yes	Yes
Paper	Bin	Minimum	Yes	Yes
Takeup	Spool	Desirable	Option	Option

Area of Difference	BBN 614	DAI 607P
Off-the-shelf availability	Standard Unit	Modification of recently developed unit plus new printer
Specification requirements	Acceptable	Acceptable
Extra Functions	Acceptable	Acceptable
Input Format	Acceptable	Excellent
Output Format	Slightly ambiguous	Excellent
Printer readability	Excellent	Acceptable

In summary, the comparison centers on the printer. It is felt that the human factors aspects of the DAI unit are superior to the BBN unit, and that this superiority outweighs the advantages of an off-the-shelf unit.

The DAI Model 607P unit is represented in Figure 2. The front panel control labels are self explanatory. The other accessible components are identified. The lid, which is not shown, is hinged at the back and protects the operating components during unattended noise level measurements.

Typical portable noise level monitor record listings are presented as Figure 3. The header presents operator entered parameter values along with the unit serial number. Noise level measurements include SEL, HNL, LEQ, and DNL. All of the record listings consist of an alpha-numeric identification and the parameter value. Further explanation of each parameter identification is presented in Figure 3 including initial values which are pre-programmed into the unit.

The performance characteristics and operating instruction for the portable noise level monitor are presented in the companion procedures document[2].

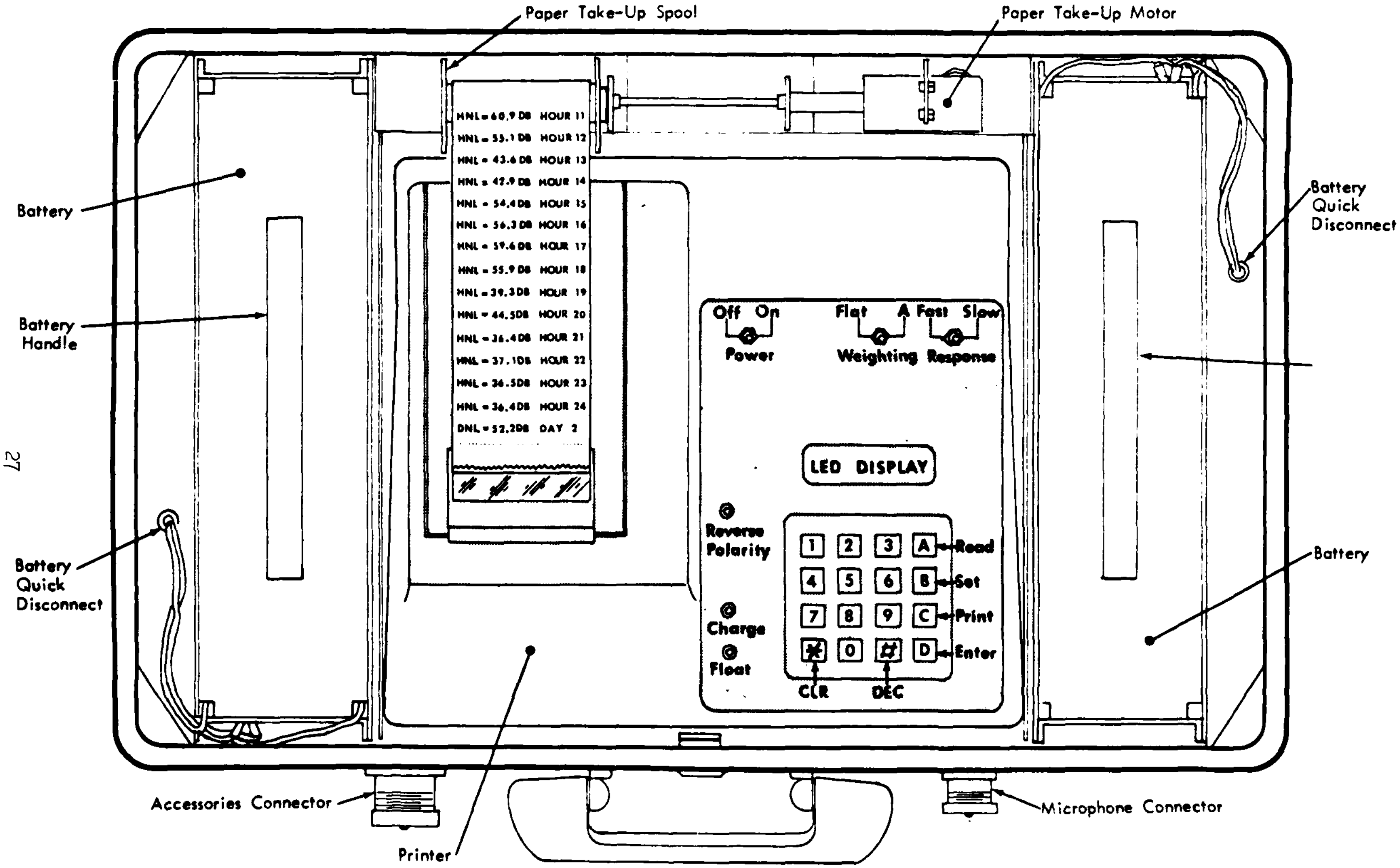


FIGURE 2. PORTABLE NOISE LEVEL MONITOR

HEADER

```
SER= 102  LOG=  2.00
CAL= 20.6DB   DAY  7
THRESHOLDS:
            SEL= 60.0DB
     HNL/CNEL=   0.0DB
INTERVAL DURATION=
              1H   0M
CNEL/DNL BEG  0H   0M
INTERVAL BEG  0H   0M
BATTERY VOLTAGE= 6.0
PRINT MODES: 1234
START AT 10H 27M 33S
```

- [illegible]rtable Noise Level Monitor unit serial number — SER= 102
- [illegible] voltage. [illegible] used on calibration — CAL= 20.6DB
- [illegible] interval duration, operator entry, 1 hour otherwise. — INTERVAL DURATION= 1H 0M
- [illegible] interval beginning, operator entry, 0 hour (midnight) otherwise. — CNEL/DNL BEG 0H 0M; INTERVAL BEG 0H 0M
- Battery voltage [illegible] maximum [illegible] minimum. — BATTERY VOLTAGE= 6.0
- Time print - zero command was entered and unit activated. — START AT 10H 27M 33S
- Location number operator entry, zero otherwise — LOG= 2.00
- Day number operator entry, zero otherwise increases automatically — DAY 7
- SEL threshold operator entry, 60.0 dB otherwise — SEL= 60.0DB
- HNL threshold operator entry (=SEL [illegible]) 0 dB otherwise — HNL/CNEL= 0.0DB
- DNL beginning operator entry, 0 hour (midnight) otherwise — CNEL/DNL BEG 0H 0M
- Functions printed 1-SEL 2-HNL 3-DNL 4-CNEL 5-LEQ operator entry 234 otherwise — PRINT MODES: 1234

NOISE LEVEL MEASUREMENTS

```
SEL= 88.8DB
MAX= 81.1DB   DAY  7
DURATION=  22.75 SEC
MAX AT   10H 49M 56S
```

- Sound Exposure Level, dB — SEL= 88.8DB
- Maximum A-weighted sound level during event — MAX= 81.1DB
- Day when SEL was measured — DAY 7
- Total time A-weighted sound level exceeded SEL threshold — DURATION= 22.75 SEC
- Time at which maximum A-weighted sound level occurred. — MAX AT 10H 49M 56S

Hourly Noise Level, dB — HNL= 74.2DB HOUR 11 — Hour when HNL was measured, 10-11 am

Hourly Noise Level, dB — HNL= 49.2DB HOUR 24 — Hour when HNL was measured, 11-12 pm

```
LEQ = 66.5DB  DAY  5
INTERVAL MAX= 66.6DB
OVER THR.24H  0M  0S
START AT  0H  0M
```

- Equivalent Noise Level, dB — LEQ = 66.5DB
- Day when LEQ was printed = measured day plus one. — DAY 5
- Maximum A-weighted sound level — INTERVAL MAX= 66.6DB
- Total time A-weighted sound level exceeded SEL threshold — OVER THR.24H 0M 0S
- [illegible] interval begun — START AT 0H 0M

Day-Night Level, dB — DNL = 73.5DB DAY 8 — Day when DNL was printed = measured day plus one.

FIGURE 3 - DESCRIPTION OF PORTABLE NOISE LEVEL MONITOR RECORD LISTINGS

The performance of portable noise level monitor units was evaluated under laboratory ambient and extreme environmental conditions. All specification parameters of Table 7 were checked (except crest factor) and were found to be in compliance. However, all units were found to exhibit a short term drift characteristic of ± 0.2 dB which is disconcerting but not critical because of the average process inherent in field measurements.

The frequency response and print quality were evaluated at -10°C (14°F) and 50°C (122°F). The frequency response deviated less than ± 1.0 dB from 20 to 15000 Hz. No discernable change in print quality occurred as a result of the extreme temperatures.

SYSTEM SAFETY PROGRAM

A system safety program was planned in accordance with MIL-STD-882[15] and conducted in conjunction with the other tasks. As a result of the experience of the field measurements program, the system safety analysis has been updated as follows:

The purpose of the system safety program was to identify potential conditions which could cause injury to the operators of the instrumentation, or incorrect measurements, or loss of equipment, or damage to the instrumentation while setting up and making discrete spot checks of the ground locations in and about Air Force air bases and to plan preventive measures.

DEFINITIONS

The following definitions apply to this system safety program:

- Safety - Freedom from those conditions that can cause injury or death to personnel, damage to or loss of equipment or property, or data.
- System Safety - The optimum degree of safety within the constraints of operational effectiveness, time and cost, attained through specific application of system safety management and engineering principles throughout all phases of a system's life cycle.

- Hazard - Any real or potential conditions such that personnel error, environment, design characteristics, procedural deficiencies, or subsystem or component failure or malfunction can cause injury or death to personnel, or damage to or loss of equipment or property.

- Accident - Injury or death to personnel, or damage to or loss of equipment or property.

HAZARD LEVEL CATEGORIES

A hazard level is a qualitative measure of hazards stated in relative terms in accordance with MIL-STD-882 as follows:

Category I - Negligible

....will not result in personnel injury or system damage

Category II - Marginal

....can be counteracted or controlled without injury to personnel or major system damage

Category III - Critical

....will cause personnel injury or major system damage, or will require immediate corrective action for personnel or system survival

Category IV - Catastrophic

....will cause death or severe injury to personnel, or system loss.

SYSTEM SAFETY PRECEDENCE

The achievement of optimal system safety has been accomplished by a number of actions. Certain types of actions are preferable, in the following order:

Design - Protective design features for each identifiable hazard have been selected if feasible and reasonable.

Safety Devices - Safety devices have been added for known hazards which could not be reduced to an acceptable level through design selection.

Procedures - Where it is not possible to preclude the existance of an identified hazard, the operating procedures were structured to minimize the probability of occurrence.

Warning Devices - Where it is not possible to preclude or minimize the probability of occurrence of an identified hazard through design and procedures, passive warning decals are to be employed.

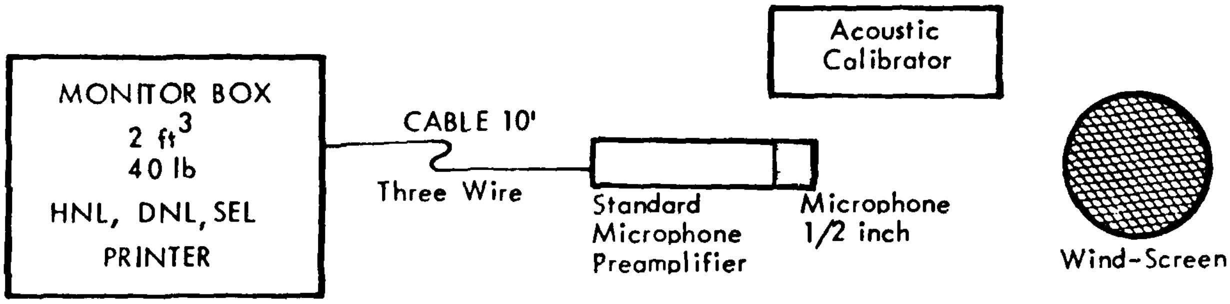
SYSTEM SAFETY ANALYSES

Three analysis techniques were employed. First, equipment use scenarios were constructed and evaluated, step-by-step, for potential hazards. Secondly, users of similar equipment listed any experience where a person was injured, equipment was damaged, or equipment was lost. Thirdly, the Barksdale AFB field test experiences with the prototype portable noise level monitor systems were compared with the preceding analyses.

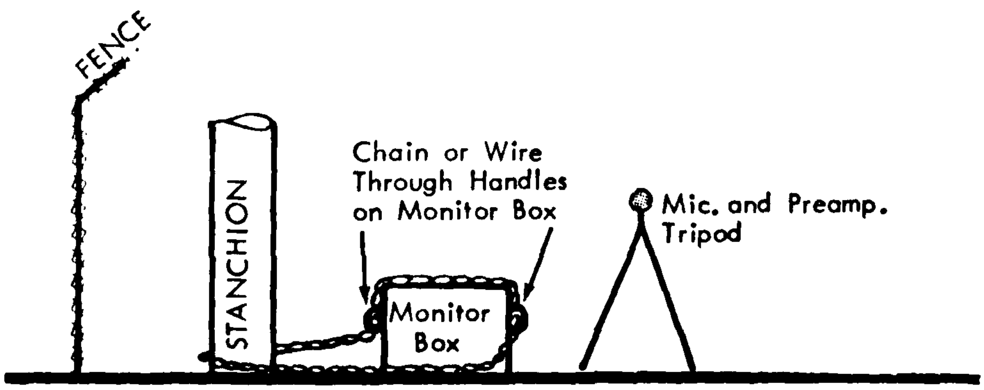
In order to construct use scenarios, a baseline installation was established, Figure 4. This installation consists of the portable noise level monitor unit chained to a stanchion but with the microphone, preamplifier, and tripod unprotected.

The use of the portable noise level monitor systems will involve at least three different modes of operation.

- Unattended operation for up to three days, measuring average hourly levels (HNL) and computing the time weighted day-night level (DNL), followed by collection of the tabulated levels and replacement of the batteries with recharged units and recalibration.
- Unattended operation for up to 24 hours, measuring sound exposure levels (SEL), occurring at a rate up to 20 per hour, followed by a collection of the tabulated levels and replacement of the batteries with recharged units and recalibration.



SYSTEM BLOCK DIAGRAM



SYSTEM INSTALLATION

FIGURE 4. PORTABLE NOISE LEVEL MONITOR SYSTEM COMPONENTS AND TYPICAL SYSTEM INSTALLATION FOR SAFETY ANALYSIS

- Attended operation, measuring SEL's occurring at a rate up to 20 per hour, while continuously annotating the tabulated results.

Interrogation, battery recharging, and recalibration will be by minimally trained personnel. These personnel will transfer the tabulated monitor readings to data summary forms for subsequent analysis by either data technicians or the field test director.

The transportation and use of the equipment is represented in Figure 5. In this figure, three types of places are shown; the storage area, the roads between storage and measurement location, and the measurement location.

Due to the nature and operation of the noise level monitoring systems, four types of hazards were defined as follows:

- Personal injury
- Incorrect data
- Equipment damage
- Equipment loss

Identified hazards were classified by type and are listed in Table 9 through 12, along with the hazard category, identification method, and corrective action taken.

GROUND HANDLING, STORAGE, SERVICING AND TRANSPORTATION

The noise level monitoring systems are intended to be portable, to be used at a variety of locations, and to be relocated daily, if necessary. Therefore, ground handling, storage, servicing, and transportation were major considerations in the design of the systems.

The noise level monitor has transportation container lined with resilient foam material to protect it from damage in normal baggage and freight handling situations.

Similarly, the fragile accessories (microphones, preamplifier, and calibrator) are transported in resilient foam material lined cases.

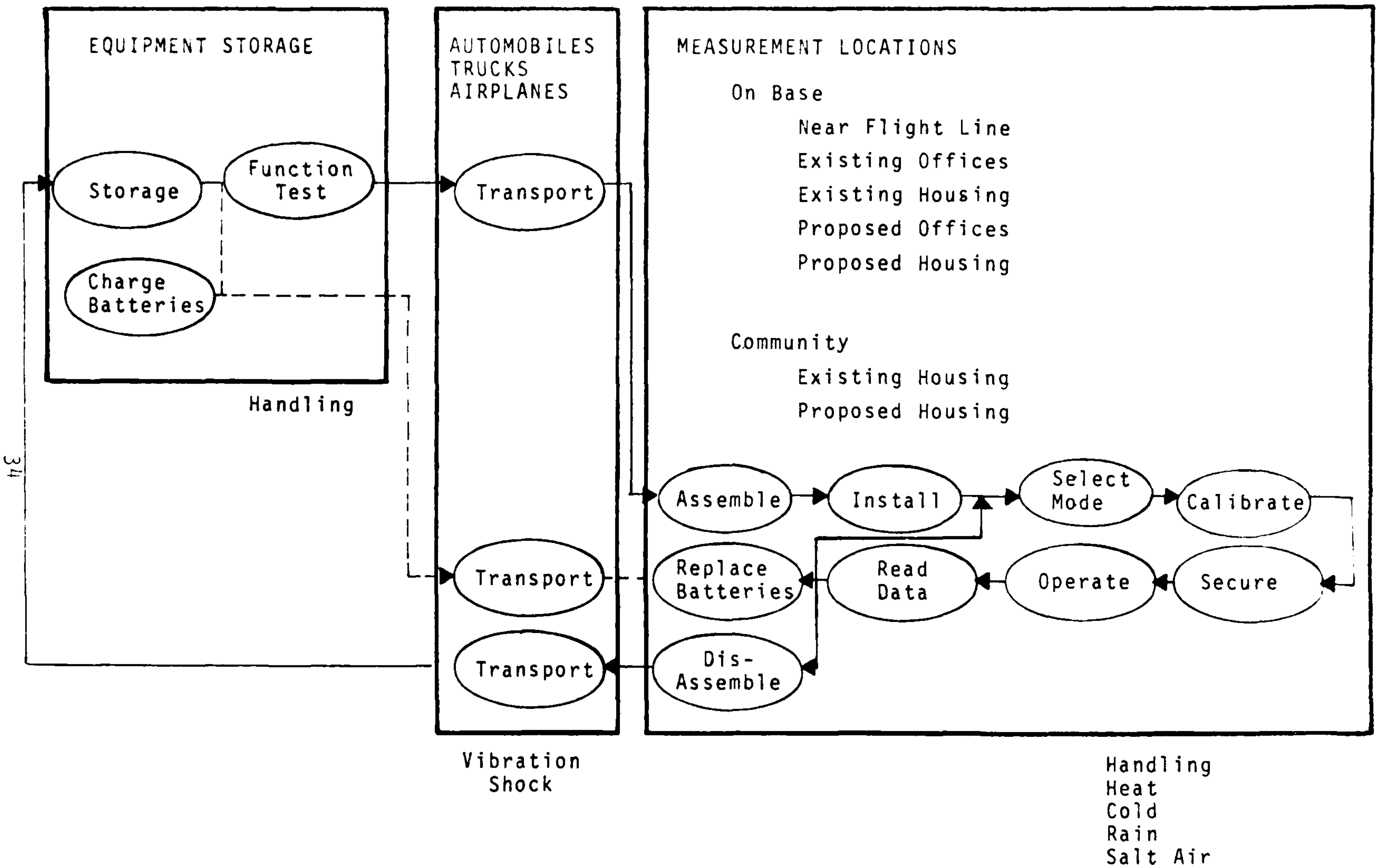


FIGURE 5. MONITOR SYSTEM EQUIPMENT
USE FLOW CHART

TABLE 9

ANALYSIS OF PERSONNEL INJURY TYPE HAZARDS

Hazard			Corrective Action			
Description	Category	Identification Method	Design Features	Safety Devices	Procedure	Warning
Shorting battery with metal tool and burning self	Critical	Previous Experience	Terminal Covers	-	-	-
Straining back while lifting unit incorrectly	Critical	Previous Experience with larger units	Light weight balanced unit	-	-	-
Falling off of building or ladders	Critical	Scenario	-	-	Work in pairs	-
Pinching fingers	Marginal	Scenario	Avoid Sharp Edges, Make batteries accessible	-	-	Decal

TABLE 10

ANALYSIS OF INCORRECT DATA HAZARDS

Hazard			Corrective Action			
Description	Category	Identification Method	Design Features	Safety Devices	Procedure	Warning
Low battery charge	Marginal	Previous Experience Barksdale	Long Battery Life	-	Check Battery Voltage	-
Incorrect instruction to monitor	Marginal	Previous Experience	Error codes	-	Check Status Printout	-
Incorrect time setting	Marginal	Previous Experience	Status Header Printout	-	-	-
Incorrect calibration	Marginal	Previous Experience	Status Header Printout	-	-	-
Incorrect readout of printer	Marginal	Experience	Clear printer format	-	-	-
Any of above	Marginal	Experience	-	-	Use log sheet printout status	-
Temperature exceeds operating limits	Marginal	Scenerios	-	-	Avoid extremes	-
Humidity exceeds operating limits	Marginal	Previous Experience	Humidity resistant microphone	Dessicant in monitor	-	-

TABLE 11

ANALYSIS OF EQUIPMENT DAMAGE HAZARDS

Hazard			Corrective Action			
Description	Category	Identification Method	Design Features	Safety Devices	Procedure	Warning
Corrosion	Marginal	Scenerios	Similar metals	-	Clean	-
Rain shorting microphone	Marginal	Previous Experience	Rain resistant microphone	-	-	
Bumping or dropping microphone	Critical	Previous Experience	Rugged microphone	Box mic-preamp-wind-screen	-	-
Stand falling or being knocked over	Marginal	Previous Experience, Barksdale Field Test	Wide sturdy tripod	Wind-screen	-	-
Dropping monitor box	Marginal	Scenerios	-	-	Remove all cables, Transport w/o batteries	-
Vandalism Manual With instrument With gun	 Critical Critical Critical	Previous Experience	-	Heavy box, chain	select location	US Govt. decal

TABLE 12

ANALYSIS OF EQUIPMENT LOSS HAZARDS

Hazard			Corrective Action			
Description	Category	Identification Method	Desgin Features	Safety Devices	Procedure	Warning
Theft of monitor system . Cut handles	Critical*	Previous Experience	-	-	Chain Tightly	-
. Extract stanchion	Critical	Previous Experience	-	-	Use big stanchion	-
. Cut chain or lock	Critical	Previous Experience	-	Proper chain and lock	-	-
. Open case, take innards	Critical	Previous Experience	-	Chain security box closed	-	-
. Any one of the above	Critical	Previous Experience	Small unit	-	Select location .safe .hidden	US Govt. decal
Theft of microphone, preamplifier and/or tripod	Critical	Scenario	-		Select location . safe . hidden	-

*The system is defined as four monitors, therefore the loss of one is not catastrophic.

FIELD MEASUREMENT DEMONSTRATION

A field test was conducted at Barksdale AFB, Shreveport, Louisiana from 5 to 22 June 1978 to demonstrate the portable noise level monitor system and to develop procedures for test planning, test conduct, data analysis, and critiqueing results. Details of the field measurement program and of the field data analysis are presented in the Appendix.

AIR BASE SELECTION

Barksdale AFB adjacent to Shreveport, Louisiana, was selected for the field measurements demonstration because of the following desirable characteristics:

- Types of missions - Both training missions and operational missions are conducted.
- Aircraft mix - Flight operations consist of both heavy aircraft (KC-135A and B-52G) and small fighter aircraft (A/T-37).
- Aircraft volume - The volume of aircraft flight operations is substantial, averaging 174 takeoffs (departures plus pattern passes) daily.
- Takeoff direction variety - The flying activity is regulated toward the southeast (Runway 14) approximately 40% of the time.
- Weather - During the scheduled field test, the temperatures, precipitation, and wind were forecast (and were, in fact) moderate.
- Political sensitivity - The NOISEMAP contours at Barksdale AFB were not under political challenge.
- Airbase cooperation - A previous measurement program (4) at Barksdale AFB had experienced willing and knowledgeable airbase cooperations.
- Documentation - NOISEMAP contours and chronicles were available.

MEASUREMENT SITES SELECTION

Three different types of site DNL problems were selected for evaluation. The types of problems are synonymous with the location of areas in relation to the flight tracks as follows:

- An area perpendicular to the flight track with a large DNL gradient (10 dB) and with the furthest point hypothetically in question because it is in the analytic model transition from air-to-ground and ground-to-ground propagation.

- An area under the flight track from one to five miles from the end of the runway where the closures of the DNL contours were hypothetically in question.

- An area under pattern flying where previous DNL measurements were hypothetically in question.

The location of the measurement sites in relation to the Barksdale AFB runway and the NOISEMAP contours are shown in Figure 6. Site 2 was used as a key site and measurements were made there during the entire field test. The conduct of the field test is described in detail in the Appendix.

DATA ANALYSIS PROCEDURES

For the purpose of this field demonstration, analysis of the data from the Barksdale AFB field test consisted of 16 separate procedures. These procedures, the type data used, and the results of the analysis are summarized in Table 13. The procedures are organized in order of increasing complexity and improved accuracy.

Before analyzing measured data, the frequencies of aircraft operations for an average day were summarized from the NOISEMAP chronicles for Barksdale AFB. This information was required for all estimates of average day DNL values. The procedure used is listed first in Table 13.

The least complex method of estimating average day DNL values from measured data was to adjust the measured DNL values for the frequency of appropriate aircraft operations. The procedures using measured DNL values are grouped together as the second listing in Table 13.

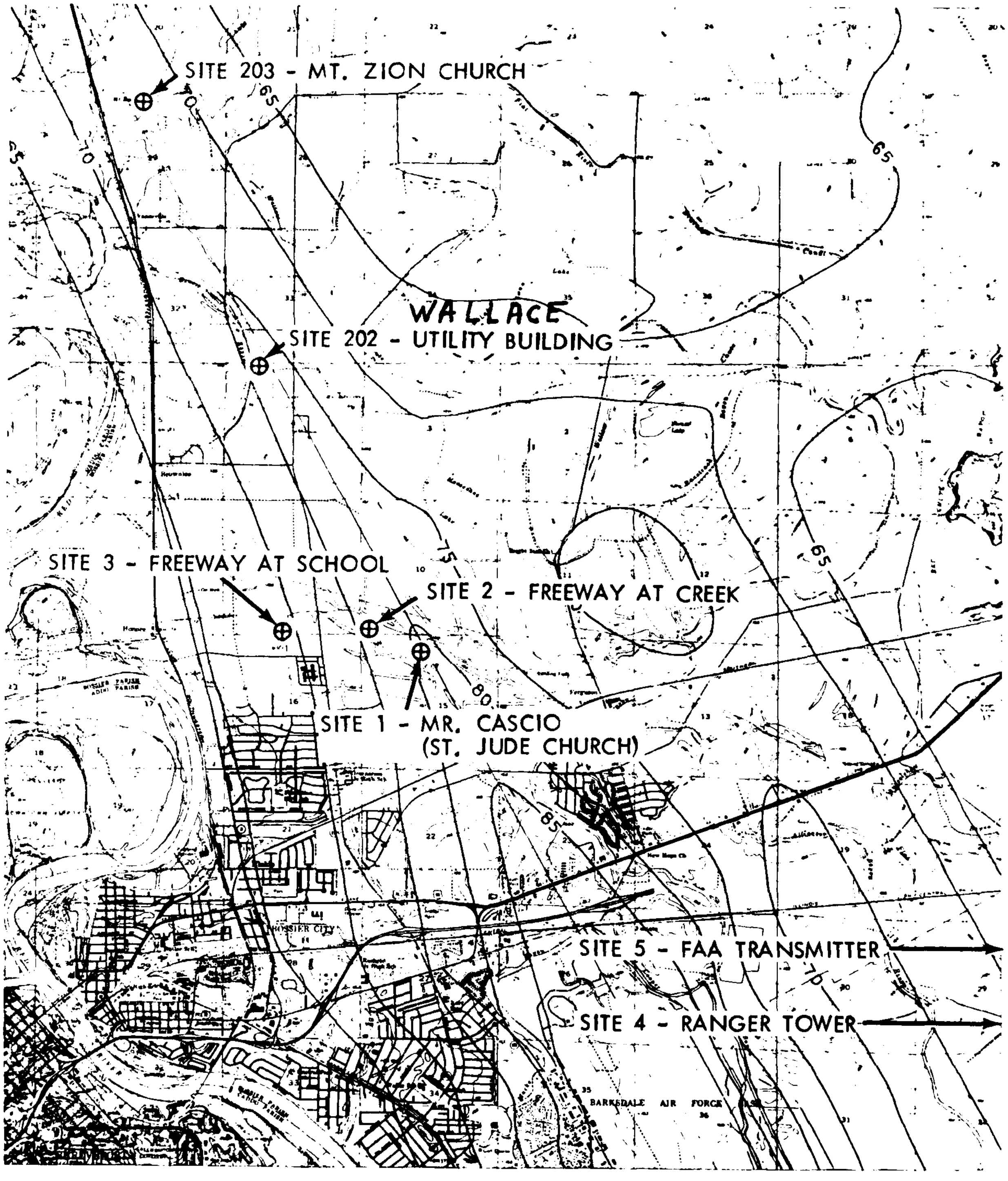


FIGURE 6. AIRCRAFT NOISE MEASUREMENT SITES AT BARKSDALE AIR FORCE BASE WITH NOISEMAP PREDICTED CONTOURS

Table 13 - Summary of Data Analysis Procedures for Field Demonstration Test

Data Used		Data Analysis Procedure	Result
Field Test	Other		
--	NOISEMAP Chrons	. Tabulate yearly average day frequencies of appropriate operations of aircraft	Average Busy Day Operations
Measured DNL Values; Tower Log	Average Day Total Number of A/C Operations over Sites	. Tabulate measured HNL and DNL values from portable noise level monitor records. . Sum appropriate flight operations from tower log. . Compute corrections based on sums of A/C Opps. . Apply corrections to measured (DNL) values; compute energy average and sample standard deviations. . Compare corrected measured and NOISEMAP DNL values	Yearly Average DNL Estimate
Measured SEL Values; Tower Log	Average Day A/C Frequency by Type Operation	. Correlate SELs from portable noise level monitor records with tower log events. . Compile measured SEL values by aircraft and type operation; calculate energy average and sample standard deviation. . Synthesize DNL values from average measured SEL values and NOISEMAP average day aircraft frequencies. . Compare synthesized and predicted DNL values.	Yearly Average DNL Estimate
Measured HNL Values; Key Site DNL Value	--	. Compute site-to-site energy differences using HNL values from portable noise level monitor records . Extrapolate satellite site DNL values from key site DNL values and site-to-site energy differences. . Compare measured and NOISEMAP DNL values.	Yearly Average DNL Estimate
Weather Logs	Yearly Temp/Humidity Values	. Compare atmospheric absorption during field test with NOISEMAP. . Compare field test average temperature with NOISEMAP. Evaluate effect of differences.	Atmospheric Bias
Sample Statistics	Student t Dist.	. Compute statistical limits at the 90% level of confidence	Confidence Intervals

The most accurate method of estimating average day DNL values employed measured SEL values. The portable noise level monitor records were correlated with the tower log. Next, the SEL values for types of aircraft and operation were compiled and averaged.

Finally, average day DNL estimates were synthesized from the averaged SEL values and NOISEMAP average day aircraft operation frequencies. The procedures using measured SEL values are grouped together in the third listing in Table 13.

An alternate method of estimating average day DNL values consists of extrapolating from a key site to satellite sites on the basis of energy averaged HNL values. The method is usually efficient in that it requires less data analysis than synthesis from SEL values. In addition, all HNL values which are measured simultaneously at both sites may be utilized, including partial day records which do not contribute measured DNL values. The procedures using measured HNL values for extrapolation to satellite sites are grouped together in the fourth listing in Table 13.

Following the estimation of average day DNL values by one or more of the above methods, the effect of weather conditions and other bias errors was evaluated. These procedures are grouped together as the fifth listing in Table 13.

Variabilities in measured data, equipment inaccuracies, and uncorrected bias errors contribute to uncertainties in average day DNL estimates. These uncertainties were expressed in terms of statistical confidence intervals around the average day DNL estimates. The procedure for developing statistical confidence intervals is the final listing in Table 13.

TEST RESULTS, CONFIDENCE INTERVALS, AND CRITIQUE

The yearly average DNL values estimated from the field measurements are presented in Table 14. Three basically different analysis procedures were carried out, with resulting different confidence intervals.

The results show that the average day DNL estimates for all sites at Barksdale AFB are consistently lower than NOISEMAP predictions. In several instances, described in the Appendix,

Table 14 Barksdale AFB Yearly DNL Estimates with Realistic Confidence Intervals Based on All Sources of Variability

Data Source	SITE 1 Avg	1 90% CI	2 Avg	2 90% CI	3 Avg	3 90% CI	202 Avg	202 90% CI	203 Avg	203 90% CI	4 Avg	4 90% CI
All Days Measurements												
No Corrections	-	-	72.0	±3.0	-	-	-	-	-	-	-	-
Corrected for total A/C	-	-	72.7	±2.4	-	-	-	-	-	-	-	-
Corrected for heavy A/C	-	-	72.6	±2.4	-	-	-	-	-	-	-	-
Week Days Measurements												
No Corrections	-	-	73.5	±2.2	-	-	-	-	-	-	-	-
Corrected for total A/C	-	-	73.2	±2.3	-	-	-	-	-	-	-	-
Corrected for heavy A/C	-	-	72.4	±2.6	-	-	-	-	-	-	-	-
SEL Synthesis Measured Data	79.1	±1.6	75.3	±1.6	68.0	±1.6	72.3	±1.6	73.2	±1.6	-	-
Extrapolation from Site 2 DNL	75.7	±2.5	-	-	66.3	±2.6	70.8	±2.6	71.1	±2.5	66.7	±2.6
NOISEMAP (REF)	80.5	-	76.4	-	69.4	-	75.8	-	73.7	-	69.0	-

the differences were traced through individual aircraft/operation SEL differences to incorrect NOISEMAP input data. This procedure requires accurate reconstruction of aircraft flight profiles from NOISEMAP chronicles to arrive at a close approximation of NOISEMAP SEL values.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations are given below regarding NOISECHECK technology. These are based upon the experience gained in procuring and in utilizing the portable noise level monitor systems in the field, and in analyzing the resulting data, as described in detail in the Appendix.

INSTRUMENTATION

Field experience with the portable noise level monitoring systems showed that all components performed reasonably well. No identifiable problems occurred with the microphones, pre-amplifiers, and accessories. No major problems were encountered with the portable noise level monitor units, although several minor problems were experienced. These were:

- The paper supply roll jammed when the unit was installed up-side-down
- Extraneous SEL's were recorded when the calibrator was left on
- The unit identifies DNL's with the following day's date.

Particular advantages of the Digital Acoustics Model 607P portable noise level monitor unit over previously available units include:

- Alpha-numeric identification of the printer output
- Header printout of unit status
- Paper supply and takeup for approximately eight day's operation
- Presentation of commands on a brightly lit display before entry.

The types of microphones, preamplifiers, and accessories employed in the prototype evaluation are all recommended for future procurement for NOISECHECK. Similarly, portable noise level monitor units satisfying the attributes and detailed specifications of Tables 6 and 7 are recommended with the following additions, or modifications:

1. Items presently in NOISECHECK, Version 1.

   Weight - 40 pounds

   Battery Life - 5 days with 200 SEL's per day

   Internal battery charger with unregulated 12 volt DC input.

2. Items for future consideration.

   DNL identification corresponding to the day measured

   Reactivation after calibration prohibited if calibrator is left on microphone.

FIELD TESTING

Much of the experience gained in undertaking the field measurements are reflected in the procedures[2]. Therefore, extensive recommendations are not set forth in this report. However, the following recommendations are felt to be particularly pertinent.

Base cooperation is necessar for a successful field test. This cooperation can be insured by advance planning and being specific as possible about requirements. However, if the base resources don't match expectations, flexibility and replanning are recommended.

Equipment security is never totally satisfactory. The preferred methods for insuring against theft are to locate in a controlled area, preferrably a private residence, and/or to properly chain the monitor unit. In the field, hypothesizing of techniques for theft and improving methods to discourage theft are recommended.

Daily recalibration of the monitor units and tabulation of the recorded values is recommended.

Analysis of the data using only measured DNL values and those corrected for aircraft volume is recommended.

The correlations between measured and predicted yearly average DNL values are obtained with measured SEL values, by aircraft, and NOISEMAP yearly average flight statistics. This method also permits tracing of the differences between measured and predicted DNL values to the aircraft and operational data input to NOISEMAP.

It is common to find differences between the predicted and measured DNL values for the various air bases. The differences normally result from inaccurate inputs to the NOISEMAP program. These errors may result from incorrect power settings, altitude profiles, flight tracks, etc. The NOISEMAP program also assumes meteorological conditions that can bias the results by up to 1 dB.

FUTURE STUDY NEEDS

In the analyses of the field data undertaken in this project, a detailed analysis of data variability was made, with subsequent calculation of statistical confidence intervals. Major sources of variability were humidity and temperature differences which were identified but not corrected for because of probable inaccuracies in the evaluation of these uncertainties. Further study into evaluating the effects of temperature and humidity on the noise generation from aircraft and transmission through the atmosphere is recommended to permit more accurate average day DNL estimates from measured data.

The variability analyses performed in this project have necessarily involved a number of assumptions regarding the root sum square addition of standard deviations, and consideration of alternate methods of calculating confidence limits. It is felt that the problem of determining accurate estimates of confidence limits needs further study, particularly taking into account the development of estimates of variability considering the period of sampling with respect to yearly variability in noise exposure.

Determining aircraft volume corrections for the measured data required summarizing the flight operational statistics from the NOISEMAP chronicles. Similarly, tracing differences between measurements and predictions required reconstructing individual aircraft/mission SEL values from the DATASCREEN chronicles. The DATASCREEN chronicles at present give the aircraft code number and mission number by runway and flight track. An additional cross reference of power profiles, delta SEL and altitude profiles would be beneficial.

Other studies that would improve the accuracy of the NOISEMAP would include an investigation of the transition model from air-to-ground versus ground-to-ground propagation. Also a study of the sound duration model as a function of distance would be beneficial.

APPENDIX

FIELD MEASUREMENTS AT BARKSDALE AFB

The field measurements program undertaken to demonstrate the portable noise level monitor system and to develop procedures for noise test planning, test conduct, and data analysis was conducted at Barksdale AFB, Shreveport, Louisiana, from 5 to 22 June 1978. Three different types of site DNL problems were selected for evaluation. The types of problems are synonymous with the location of areas in relation to the flight tracks as follows:

1. An area perpendicular to the flight track with a large DNL gradient (10 dB) and with the furthest point hypothetically in question because it is in the analytic model transition from air-to-ground and ground-to-ground propagation.

2. An area under the flight track from one to five miles from the end of the runway where the closures of the DNL contours were hypothetically in question.

3. An area under pattern flying where previous DNL measurements were hypothetically in question.

The location of the measurement sites in relation to the Barksdale AFB runway and the day-night level (DNL) contours are shown in Figure 6 of this report. This figure was developed by tracing the DNL contours* onto a 7.5 minute series (topographic) Geological Survey map.

TEST CONDUCT

Upon arrival at Barksdale AFB, a coordination meeting was arranged with the base commander by the base civil engineering personnel. The activities represented were as follows:

*The DNL contours were computed and drawn by NOISEMAP. NOISEMAP contours and chronicles were obtained from AFESC, Tyndall AFB, Florida 32403 through Hq. SAC/DEV Offutt AFB, Nebraska.

Activities Represented at Coordination Meeting

Organization	Activity
Barksdale AFB	Base Commander
"	Assistant Base Commander
"	Civil Engineering
"	Weather Station
"	Tower Operations
"	FAA Rapcon
"	Base Hospital (Environmental Health
WPAFB	AMRL/BBE
Brooks AFB	OEHL/ECH
BBN	Contractor

The specific measurement site selections were made after inspection of the areas. Only the pattern flying area was over air base property. Therefore, permission to install measurement systems had to be obtained from civilian property owners. The sites and methods for obtaining necessary permissions are as follows:

Type Area	Site Number	Site Description	Method of Obtaining Permission
Perpendicular to flight track	1	St. Jude Church	Telephone
	2 (key)	Freeway/Creek	Visit Contruction Supervisor
	3	Freeway/Airport School	"
Parallel to flight track	2 (key)	Freeway/Creek	Visit Construction Supervisor
	202	Wallace Utility	Visit Mrs. Wallace
	203	Mt. Zion Church	Telephone Church Officials
Patterns	2 (key)	Freeway/Creek	Visit Construction Supervisor
	4	Ranger Tower	Contact Base Ranger
	5	FAA transmitter	Contact Base FAA

Microphone installations at four of the six measurement sites are shown in Figure A-1. The terrain at all sites was essentially flat. Trees were present around all sites, but care was taken to ensure unobstructed line of sight to the aircraft at least at the point of closest approach. The noise monitor units, which are out of the fields of view in the installation pictures, were secured against theft. At Site 202, the monitor unit was locked inside the Wallace utility building. At all other sites, a chain was passed under the handle, around the unit, and snugly locked. This prevented opening of the unit. The rest of the chain was routed around a tree or fence post and locked with a second lock. A plastic bag was then draped over the unit to shield it from rain and to make the installation less visible.

The chronology of the field test is presented in Table A-1. Three noise level monitor units were used to perform measurements at five sites. During the course of the field test, a fourth unit was installed at the sixth site. However, the fourth unit was subsequently found to have a defect causing erratic data.

During the first week, BBN, OEHL/ECH, and AMRL/BBE personnel participated actively. During the second week, BBN was assisted by base personnel. These same base personnel performed the necessary recalibration, moving, and shipping of the instrumentation during the third week.

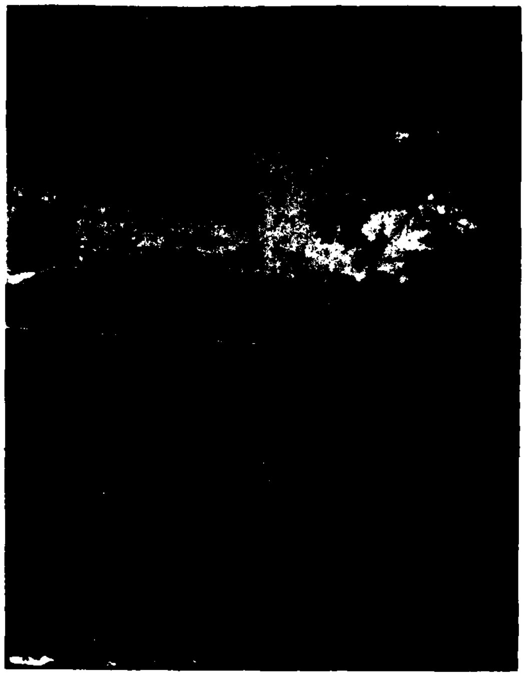
At the request of the field measurement team, aircraft operations logs and weather logs were maintained by the Barksdale AFB tower and weather personnel, respectively.

DATA COLLECTION

NOISE LEVEL DATA

The noise levels measured by the portable noise level monitors are automatically printed on paper tape records. The printer listings are described in Figure 3 of this report.

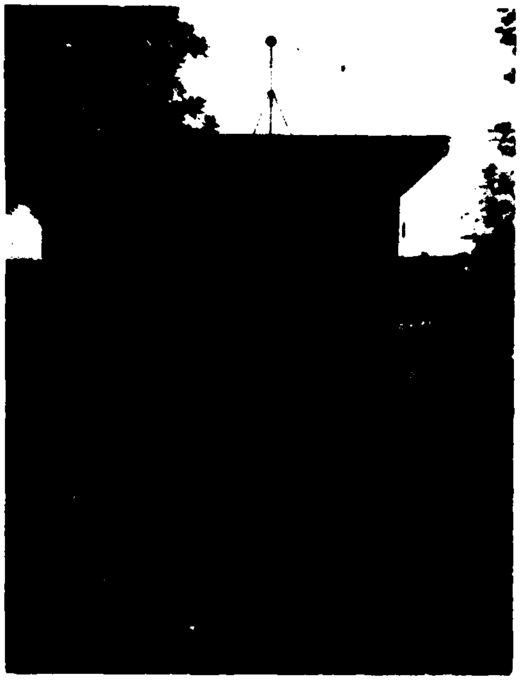
Data records from three monitor units were edited to synchronize the SEL, HNL, and DNL listings and are presented in Figure A-2.



(a) Site 2, Looking North

(b) Site 3, Looking Across Highway To Airport School, Calibrator on Microphone.

(c) Site 203, Mt. Zion Church Looking South



(d) Site 202, Wallace Utility Building Looking East.

Figure A-1 Microphone Installations at Measurement Sites 2, 3, 202 and 203.

Table A-1

Chronology - Barksdale AFB Field Noise Level Measure[illegible]

Day	(June 78)	Activity	Site Number: Unit 101	Unit 102	Unit 103	Unit 108
Mon	5	Meeting with base CMDR Surveyed sites	-	-	-	
Tues	6	Selected sites, installed units	1	2	3	-
Wed	7	Found paper jam	1	2	3	-
Thurs	8	Serviced units, extra SEL	1	2	3	-
Fri.	9	Serviced units	1	2	3	-
Sat.	10	Serviced Units, Found 102 mic knocked over by cow	1	2	3	-
Sun.	11	Moved 101	1/202	2	3	-
Mon.	12	Moved 103	202	2	3/203	-
Tue.	13	Serviced Units	202	2	203	-
Wed.	14	Serviced Units	202	2	203	-
Thur	15	Moved 101, Reset 103, Installed 108	202/4	2	203	5
Fri	16	108 data erratic	4	2	203	5
Sat	17	-	4	2	203	5
Sun	18	Serviced units	4	2	203	5
Mon	19	Serviced units	4	2	203	5
Tues	20	Tower stopped log	4	2	203	5
Wed	21	101, 108 packed up	-	2	203	-
Thur	22	102, 103 packed up	-	2	203	-

SER= 101 LOC= 1.00
CAL= 81.4DB DAY 7
THRESHOLDS:
SEL= 60.0DB
HNL/CNEL= 0.0DB
INTERVAL DURATION=
1H 0M
CNEL/DNL BEG 0H 0M
INTERVAL BEG 0H 0M
BATTERY VOLTAGE= 6.0
PRINT MODES: 1234
START AT 9H 30M

SEL=115.9DB *B-52*
MAX=106.5DB DAY 7
DURATION= 80.25 SEC
MAX AT 10H 32M

SEL= 81.4DB *C-130*
MAX= 72.7DB DAY
DURATION= 22.37
MAX AT 10H 39M

SEL= 86.2DB *C-130*
MAX= 78.1DB DAY
DURATION= 22.75 SEC
MAX AT 10H 49M

HNL= 80.5DB HOUR

SEL= 86.1DB *C-130*
MAX= 78.5DB DAY
DURATION=
MAX AT 11H 3M

SEL= 94.2DB *T-39*
MAX= 85.7DB DAY
DURATION= 36.25 SEC
MAX AT 11H 37M

HNL= 58.2DB HOUR 24

DNL = 77.9DB DAY 8

CNEL= 79.7DB DAY 8

SER= 102 LOC= 2.00
CAL= 20.6DB DAY 7
THRESHOLDS:
SEL= 60.0DB
HNL/CNEL= 0.0DB
INTERVAL DURATION=
1H 0M
CNEL/DNL BEG 0H 0M
INTERVAL BEG 0H 0M
BATTERY VOLTAGE= 6.0
PRINT MODES: 1234
START AT 10H 27M

SEL=109.0DB *B-52*
MAX= 98.6DB DAY 7
DURATION= 32.00 SEC
MAX AT 10H 32M 23S

SEL= 65.3DB *C-130*
MAX= 62.2DB DAY 7
DURATION= 02.75 SEC
MAX AT 10H 39M

SEL= 88.8DB *C-130*
MAX= 81.1DB DAY 7
DURATION= 22.75 SEC
MAX AT 10H 49M 56S

HNL= 74.2DB HOUR 11

SEL= 87.3DB *C-130*
MAX= 78.9DB DAY 7
DURATION= 21.87 SEC
MAX AT 11H 3M 5S

SEL= 95.5DB *T-39*
MAX= 86.3DB DAY 7
DURATION= 39.50 SEC
MAX AT 11H 37M 27S

HNL= 49.2DB HOUR 24

DNL = 73.5DB DAY 8

CNEL= 74.6DB DAY 8

SER= 103 LOC= 3.00
CAL= 22.4DB DAY 7
THRESHOLDS:
SEL= 60.0DB
HNL/CNEL= 0.0DB
INTERVAL DURATION=
1H 0M
CNEL/DNL BEG 0H 0M
INTERVAL BEG 0H 0M
BATTERY VOLTAGE= 6.0
PRINT MODES: 1234
START AT 9H 58M

SEL=101.7DB *B-52*
MAX=
DURATION=
MAX AT 10H 32M

SEL= 65.8DB *C-130*
MAX= 60.4DB DAY
DURATION= 03.50 SEC
MAX AT 10H 39M

SEL= 79.2DB *C-130*
MAX= 62.4DB
DURATION= 20.75
MAX AT 10H 50M

HNL= 66.7DB HOUR

SEL= 77.4DB *C-130*
MAX= 60.4DB DAY
DURATION= 21.25 SEC
MAX AT 11H 3M

SEL= 86.8DB *T-39*
MAX= 77.3DB
DURATION= 38.50
MAX AT 11H 37M

HNL= 54.5DB HOUR

DNL = 66.1DB DAY 8

CNEL= 66.8DB DAY

FIGURE A-2 - TYPICAL PORTABLE NOISE LEVEL MONITOR DATA RECORDS

The data records in this figure show three different types of entries--status header, SEL's, and HNL's. The status header, which is printed on operator command, must be printed to initiate computation. The time period covered immediately follows the recalibration of unit S/N 102 at location 2.

CALIBRATION OFFSET

During calibration, the portable noise level monitor calculates the ratio of the incoming signal voltage to an internal reference of 1.16 vrms. This ratio, expressed in dB, is called the calibration offset. Variation in the calibration offset is a measure of the drift of part of the calibrator-microphone-pre-amplifier-monitor system. The calibration offset values from the field test are presented in Table A-2. The range of the values for each unit is greater than the ± 0.2 dB observed under ambient laboratory conditions. Possible sources of variation in calibration offset under field conditions are improper seating of the calibrator on the microphone and not allowing the calibrator to stabilize for at least 30 seconds before doing the calibration.

The calibration offset value is applied to calculated levels at the time the particular noise value is printed. Therefore, if the calibration offset changes during mid-day recalibration, the previous SEL and HNL values are based on the previous calibration offset and subsequent SEL and HNL values are based on the new calibration offset. In addition, the DNL value at the end of that day is based on the mid-day calibration offset even though the energy was accumulated throughout the entire day. This computation method will cause minor differences between measured DNL values and values calculated from HNL values.

Since the calibration offset variation appeared to be random in nature, no daily corrections were applied to the measured data. Instead, the variation was considered an uncertainty which was used, along with other uncertainties, to determine statistical confidence intervals.

AIRCRAFT TOWER LOGS

The flight control tower maintained log of aircraft operations during the field measurement program. A typical log sheet is presented as Table A-3*. This log sheet covers the

*The tower log data sheet was redesigned after the test program. The data in Table A-3 were copied from the original to the new form.

TABLE A-2 PORTABLE NOISE MONITOR CALIBRATION OFFSET VALUE HISTORY

Day	Date	Unit S/N 101	Unit S/N 102	Unit S/N 103	Unit S/N 108
T	6 June 1978	21.5	20.0	22.2	-
W	7	21.4	20.2	22.4	-
Th	8	21.6	20.7	23.0	-
F	9	21.4	20.7	22.6	-
S	10	21.4	21.5	22.6	-
S	11	21.5	21.5	22.7	-
M	12	22.2	20.4	22.6	-
T	13	21.6	20.4	22.8	-
W	14	21.6	20.7	23.0	-
Th	15	21.5	20.6	22.8	23.9
F	16	21.5	20.6	22.2	23.9
S	17	-	-	-	-
S	18	22.0	20.7	22.6	23.3
M	19	-	20.7	22.6	24.2
T	20	22.0	20.9	22.7	24.5
W	21	-	-	-	24.8
Th	22	-	-	22.7	24.8

TABLE A-3

AIRCRAFT TOWER LOG AND NOISE MONITOR DATA TABULATION FORM

Installation BAFB
Date 7 JUNE '78
Runway(s) 14 /32

Aircraft Type								Operation		Time		Noise Monitor Data			
KC-135A	B-52G	A-37	T-37	T-38	T-39	C-130	Other	Apprch*	T/O+	GMT	Local	Time	SEL, dB	Dur, sec	Max, dB
		✓						P	P	1358	0858				
						✓		P	P	1359	0859				
		✓						P	P	1403	0903				
						✓		P	P	1405	0905				
		2							SO (2)	1408	0907				
		✓						P	P	1408	0908				
		✓							SO	1410	0910				
							C-9		SO	1411	0911				
		✓						P	P	1412	0912				
						✓		P	P	1413	0913				
		✓						P	P	1418	0918				
		✓						P	P	1425	0925				
						✓		P	P	1427	0927				
		✓						P	P	1430	0930				
							C131	SI		1432	0932				
		2						P (2)	P (2)	1439	0939				
						✓		P	P	1441	0941				
			✓						SO	1443	0943				
		✓						P	P	1445	0945				
		✓						P	P	1448	0948				
		✓						P	OUT	1450	0950				
←				CHANGE				TO	32	→					
		2						P (2)	P (2)	1454	0954				
						✓		P	P	1456	0956				
		✓						SI		1459	0959				
		✓						P	P	1502	1002				
						✓			OUT	1506	1006				
		2						SI (2)		1509	1009				
		✓						SI		1513	1013				
		✓						SI		1514	1014				

*Approach - SI - Straight In
P - Pattern

+Takeoff SO - Straight Out
P - Pattern

R - Right Turn Departure
L - Left Turn Departure

time from 8:58 to 10:14 on 7 June 1978. During that period of time, the runway was changed from 14 (approaches over the measurement sites) to 32 (takeoffs over the measurement sites). Note that no heavy aircraft operations (B-52 or KC-135) took place. The heavy aircraft operations usually occurred early and late in the day.

WEATHER LOGS

Weather logs were maintained by the base weather office. The temperature and relative humidity were tabulated every three hours for the duration of the test program. A typical weather log sheet is presented as Table A-4. This particular log sheet covers the time period from 5 June through 9 June 1978.

PROBLEMS ENCOUNTERED

During the course of the field measurements, various problems were encountered and mistakes were made.

- On five occasions during the daily recalibration procedure, a monitor unit was reactivated before the calibrator was removed. This caused an extra SEL with significantly more energy than the rest of the daily aircraft operations. To rectify each of these mistakes, the affected HNL was reconstructed from SEL's, and the affected DNL was reconstructed form the corrected HNL's.

- During the initial installation, two monitor units were tipped back over against a nearby tree. This procedure caused the paper supply reel in the thermal printer to jam. Nevertheless, much usable data were obtained because the paper take-up mechanism partially overcame the jamming. The jam because more serious, the print height became smaller, and finally no data were printed. It should be noted that on any such occasion, the values for the last SEL, HNL, and most importantly the last DNL may be read on the monitor LED display.

- A microphone in it tripod was set on the pasture side of a fence to make it less visible. However, a number of cows visited the area, knocking over the tripod. Fortunately, no damage to the instruments was incurred. In addition, the cows were present at the time the monitor unit was inspected and the knocking over was assumed to have recently occurred, with no apparent loss of data.

TABLE A-4 WEATHER LOG

DATE/TIME(L)	WIND DIR/SPEED (°TRUE/KTS)	TEMP (°F)	REL HUMIDITY	DATE/TIME(L)	WIND DIR/SPEED (°TRUE/KTS)	TEMP (°F)	REL HUMIDITY
05/0100CDT	CALM	71	84%	07/1300CDT	050/02	77	72
0400	CALM	69	90%	1600	240/02	79	68%
0700	CALM	67	90%	1900	140/01	79	68%
1000	180/06	79	67%	2200	170/02	73	86%
1300	160/05	85	51%	08/0100CDT	290/03	74	82%
1600	110/06	86	49%	0400	270/02	72	84%
1900	120/03	84	56%	0700	280/05	71	84%
2200	080/01	76	74%	1000	330/06	77	64%
06/0100CDT	CALM	73	76%	1300	280/06G16	84	51%
0400	140/02	72	78%	1600	330/12	85	49%
0700	170/03	73	87%	1900	060/04	81	60%
1000	190/11G17	84	67%	2200	CALM	73	78%
1300	150/05	76	82%	09/0100CDT	340/05	68	81%
1600	150/08G14	75	85%	0400	350/04	63	86%
1900	190/08	77	79%	0700	020/04	64	81%
2200	180/07	74	84%	1000	040/08	74	59%
07/0100CDT	150/02	72	87%	1300	330/09	79	50%
0400	270/04	72	76%	1600	070/04	82	44%
0700	140/05	71	84%	1900	030/06	80	43%
1000	CALM	73	76%	2200	090/02	68	80%

- Tower personnel stopped keeping the aircraft operations log as originally instructed on Tuesday, June 20, while measurement program was extended until Thursday, June 22. The conduct of the test had been turned over to the base personnel the previous Thursday with mostly verbal instructions. Fortunately, the loss of information was not critical to the Barksdale AFB field test program. The event possibly could have been avoided by making explicit agreements with supporting personnel and/or reviewing the daily progress by telephone.

- The portable noise level monitor units sensed and recorded SEL events which could not be correlated with aircraft operations. The SEL values were generally low with short durations. While recalibrating unit 103 at site 3, extraneous SEL events were attributed to a mowing tractor operating on the other side of the unopened freeway. Such extraneous SEL events could have been avoided by setting the SEL threshold to a value higher than the 60 dB pre-set level. Subsequently, the threshold level was raised to 65 dB which did reduce the number of extraneous SEL events, but they still outnumbered aircraft-related events. The threshold was maintained at a level lower than necessary for heavy aircraft in order to measure the noise levels of the small aircraft. This would have been unnecessary for a typical site validation. Virtually no significant SEL information would have been lost by setting the SEL threshold at 25 dB below the maximum A-weighted sound level which was 95 to 105 dB depending on the site.

- On one occasion, the paper became misaligned on the paper take-up reel and folded over on one edge. The problem was traced to factory alignment of the printer. By re-adjusting the printer in the factory, the misalignment problem was solved.

- On one occasion, the battery voltage dropped below that necessary to run the printer. This came about by using only one battery in the unit while the second battery was being recharged in the laboratory. On the occasion in question, the portable noise level monitor unit was left unattended for an extra day. Fortunately, even though the printer failed to document SEL's and HNL's, the unit was still calculating. With fresh batteries, the unit resumed printing. At the end of that day the unit listed the DNL value for the whole day.

NOISEMAP AIRCRAFT OPERATIONS

The frequencies of aircraft operations over the measurement sites for the six most frequently flow aircraft were determined from the NOISEMAP chronicles and listed in Table A-5. For synthesis of DNL values from measured SEL values, four different types of aircraft operation were considered as follows:

Straight-in Approach
Pattern Approach
Pattern Takeoff
Straight-Out Takeoff

The number of each type of operation over the northern measurement sites for both daytime and nighttime were derived by summing of appropriate mission frequencies. For example, four different KC-135A pattern flying missions are listed as departing on Runway 32 with a total rate of 8.240 during the day and 1.780 during the night.

For each type of aircraft operation, the number of nighttime operations was multiplied by 10 and added to the number of daytime operations to arrive at equivalent number of daily operations shown in Table A-5. The sum of the equivalent daytime operations, 329, was subsequently used to correct measured DNL values. In addition, the number of equivalent daily operations for heavy aircraft (B-52G and KC-135A) was determined. This number, 174, was alternatively used to correct measured DNL values.

The numbers of practice operations were similarly derived for correcting measurements at the sites under the practice flight tracks in the east reservation. Noting that all pattern operations are routed over the measurement sites north of the runway, the number of pattern operations is simply the sum of practice approaches and takeoffs.

ANALYSIS USING MEASURED DNL VALUES

TABULATION OF MEASURED HNL AND DNL VALUES

The measured HNL and DNL values tabulated directly from the portable noise monitor unit records for each of the five sites are listed in Table A-6. For those situations during recalibration when the calibrator was not removed before the portable noise level monitor was reactivated, the HNL value was reconstructed from the valid SEL values as follows:

TABLE - DAILY FREQUENCIES OF FLIGHT OPERATIONS OVER NORTHERN MEASUREMENT SITES FROM NOISEMAP CHRONICLES

Type A/C	Operations: App SI	Operations: App Pattrn	Operations: T/O Pattrn	Operations: T/O SO	Frequency: Day	Frequency: Night	Frequency: Equiv. Day, N*
KC - 135A	✓				3.180	0.510	8.28
		✓			12.412	2.670	39.11
			✓		8.240	1.780	26.04
				✓	2.871	0.426	7.13
B52G	✓				2.910	0.960	12.51
		✓			9.750	3.600	45.75
			✓		6.480	2.400	30.48
				✓	2.436	0.225	4.68
A-37	✓				14.430	0.092	15.35
		✓			7.168	0.144	8.60
			✓		4.770	0.099	5.76
				✓	5.420	0.140	6.82
T-37	✓				5.400	0	5.40
		✓			19.260	0	19.26
			✓		10.50	0.02	10.70
				✓	3.580	0.02	3.78
T-38	✓				1.780	0.102	2.80
		✓			4.160	0.298	7.14
			✓		2.548	0.172	4.26
				✓	1.190	0.07	1.89
T-39	✓				2.540	1.220	14.74
		✓			5.230	0.190	7.13
			✓		3.490	0.820	11,69
				✓	2.370	0.130	3,67
Other	✓				2.80	0.10	3.80
		✓			5.875	0.57	11.57
			✓		4.08	0.41	8.18
				✓	1.75	0.07	2.45
App. and T/O	All A/C				156.6	17.238	329
	Heavy A/C				48.28	12.57	174
Pattrn (REF)	All A/C				102.2	13.17	234
	Heavy A/C				36.9	10.45	1414

[illegible]	-	-	-	-	-	-	[illegible]	[illegible]	-	-	-	-	[illegible]	[illegible]	54.9			-
[illegible]	-	-	-	-	-	-	54.7	[illegible]	-	-	-	-	[illegible]	[illegible]	[illegible]			
[illegible]	-	-	-	-		-	[illegible]	[illegible]	-	-	-	-	[illegible]	[illegible]	52.9	-	-	-
[illegible]	-	-	-	-	-	-	[illegible]	[illegible]	-	-	-	-	[illegible]	[illegible]	[illegible]	-		
[illegible]	-	-	-	-	-	-	53.6	[illegible]	-	-		-	[illegible]	[illegible]	47.7			
[illegible]	-	-	-	-	-		[illegible]	[illegible]		-	-		[illegible]	48.5	[illegible]	-	-	-
[illegible]	-	-	-	-	-	-	[illegible]	[illegible]	-		-	-	[illegible]	[illegible]	[illegible]	-		-
[illegible]	-	-	-	-	-	-	[illegible]	[illegible]	-		-		[illegible]	[illegible]	71.0	-		
[illegible]	-	-	-	-	-	-	60.8	-		-	-	-	[illegible]	[illegible]	64.2	-	-	-
[illegible]	-	-	-	-	-	-	66.7	-	[illegible]	-		-	79.9	79.5	72.5	-	-	-
[illegible]	-	-	-	-	-	-	80.9	74.6	67.1	-	-	-	66.0	64.5	[illegible]	-	-	-
12	-	-	-	-	-	-	81.5	81.8	72.9	-	-	-	63.7	59.9	54.8	-	-	-
13	-	-	-	-	-	-	71.9	73.4	68.4	-	-	-	82.7	76.9*	69.0	-	-	-
14	-	-	-	-	-	-	79.3	78.5	71.7	-	-	-	72.2	72.8	68.4	-	-	-
15	-	-	-	-	-	-	75.0	65.1	59.4	-	-	-	63.0	57.0	68.7	-	-	-
16	-	-	-	-	-	-	75.3	64.1	61.2	-	-	-	73.4	61.0	60.6	-	-	-
17	-	-	-	-	-	-	48.8	46.1	48.8	-	-	-	75.8	65.9	61.4	-	-	-
18	76.8	69.0	57.9	-	-	-	83.7	75.3	65.9	-	-	-	79.3	78.0	64.8	-	-	-
19	53.2	48.1	52.8	-	-	-	83.7	81.1	70.9	-	-	-	85.1	82.7	74.5	-	-	-
20	70.3	61.8	-	-	-	-	86.3	79.3	69.1	-	-	-	64.2	62.3	61.9	-	-	-
21	60.1	50.4	-	-	-	-	54.7	46.3	55.2	-	-	-	54.8	49.7	51.3	-	-	-
22	56.2	45.3	-	-	-	-	57.5	48.6	59.9	-	-	-	63.0	52.7	56.9	-	-	-
[illegible]	56.6	47.7	-	-	-	-	57.6	48.2	57.1	-	-	-	65.5	57.5	58.9	-	-	-
[illegible]	[illegible]	[illegible]	-	-	-	-	[illegible]	[illegible]	[illegible]	-			54.3	[illegible]	[illegible]	-	-	-
[illegible]			-	-	-	-	[illegible]	[illegible]	[illegible]		-	-	[illegible]	74.4	[illegible]			
[illegible]							[illegible]	[illegible]			-	-	[illegible]	[illegible]	[illegible]			

* [illegible]

Calibration correction applied

Day Hr Site	Friday, 9 June 1978 1	2	3	202	203	4	Saturday, 10 June 1978 1	2	3	202	203	4	Sunday, 11 June 1978 1	2	3	202	203	4
1	54.4	40.2	55.7	-	-	-	47.6	42.0	53.9	-	-	-	59.6	43.7	53.7	-	-	-
2	56.1	44.1	49.8	-	-	-	54.5	44.9	47.8	-	-	-	60.0	43.1	55.9	-	-	-
3	53.6	42.4	45.4	-	-	-	43.6	37.3	44.7	-	-	-	60.3	45.6	56.7	-	-	-
4	53.1	37.2	49.1	-	-	-	38.5	34.3	41.5	-	-	-	58.8	46.4	54.7	-	-	-
5	50.5	39.8	52.1	-	-	-	43.7	40.5	42.9	-	-	-	56.2	46.4	49.4	-	-	-
6	58.8	58.1	55.4	-	-	-	39.5	39.3	49.3	-	-	-	51.6	43.1	50.5	-	-	-
7	48.2	41.9	57.3	-	-	-	50.5	48.3	51.6	-	-	-	45.6	43.1	47.2	-	-	-
8	84.6	85.5	83.3	-	-	-	48.0	43.5	49.2	-	-	-	49.4	44.6	47.5	-	-	-
9	82.6	75.1	67.5	-	-	-	50.1	50.2	53.5	-	-	-	55.4	52.1	52.4	-	-	-
10	67.8	63.0	61.4	-	-	-	52.6	48.8	50.5	-	-	-	58.6	53.7	54.1	-	-	-
11	64.9	57.8	55.1	-	-	-	61.3	54.5	50.2	-	-	-	61.9	48.1	54.4	-	-	-
12	79.2	79.4	67.8	-	-	-	58.0	49.3*	47.1	-	-	-	56.9	49.4	52.7	-	-	-
13	70.9	73.2	70.1	-	-	-	54.7	44.8	51.1	-	-	-	57.2	54.4	52.2	-	-	-
14	79.5	76.5	68.5	-	-	-	60.7	59.6	54.5	-	-	-	60.9	44.1	48.2	-	-	-
15	78.4	70.2	61.7	-	-	-	55.6	45.2	51.1	-	-	-	-	64.2	56.7	-	-	-
16	83.5	79.1	71.2	-	-	-	74.7	65.9	57.6	-	-	-	-	65.8	58.9	62.2*	-	-
17	73.3	67.6	60.2	-	-	-	70.1	60.5	56.5	-	-	-	-	56.2	57.6	56.3	-	-
18	80.1	82.2	71.3	-	-	-	59.7	54.0	52.0	-	-	-	-	57.1	53.5	57.0	-	-
19	62.5	55.8	53.4	-	-	-	56.5	41.6	50.3	-	-	-	-	43.0	58.0	53.0	-	-
20	66.1	72.5	70.9	-	-	-	51.2	43.9	48.5	-	-	-	-	50.6	53.0	55.5	-	-
21	69.5	58.8	53.9	-	-	-	54.4	46.5	52.5	-	-	-	-	43.8	54.6	60.8	-	-
22	76.5	62.7	58.5	-	-	-	59.9	45.4	57.8	-	-	-	-	46.1	57.9	50.6	-	-
23	48.5	43	57.6	-	-	-	59.5	44.0	54.7	-	-	-	-	45.9	61.2	46.0	-	-
24	46.9	43.8	55.9	-	-	-	59.0	45.1	53.3	-	-	-	-	46.0	59.9	42.7	-	-
[illegible]	76.9	75.4	70.4	-	-	-	64.6	55.7	57.8	-	-	-	-	56.5	62.6	-	-	-
[illegible]	76.8	75.4	70.8	-	-	-	63.1	54.7	52.6	-	-	-		48.3	58.[illegible]		-	-

*Reconstructed from valid [illegible] values

**Calibration correction [illegible]

[illegible]	-	[illegible]	[illegible]	[illegible]			-	[illegible]	-	[illegible]	[illegible]	-	-	[illegible]	-	[illegible]	[illegible]	
[illegible]	-	46.5	[illegible]	[illegible]	-	-	-	[illegible]		[illegible]	[illegible]	-	-	[illegible]		[illegible]	[illegible]	-
3	-	[illegible]	[illegible]	[illegible]	-	-	-	[illegible]	-	44.0	41.6	-	-	61.5	-	[illegible]	43.7	-
[illegible]	-	43.8	[illegible]	42.1			-	[illegible]	-	[illegible]	[illegible]	-	-	60.4	-	[illegible]	[illegible]	-
[illegible]		[illegible]	57.7	36.7	-	-	-	[illegible]	-	46.6	37.8	-	-	46.7	-	[illegible]	[illegible]	-
[illegible]	-	[illegible]	[illegible]	[illegible]	-	-	-	[illegible]	-	44.7	[illegible]	-	-	56.6	-	45.6	[illegible]	-
[illegible]		[illegible]	[illegible]	[illegible]	-	-	-	[illegible]	-	48.9	39.6	-	-	56.7	-	[illegible]	41.2	-
[illegible]	-	[illegible]	[illegible]	[illegible]	-	-	-	[illegible]		[illegible]	74.9	-	-	[illegible]		61.5	[illegible]	
[illegible]	-	66.1	[illegible]	49.1		-	-	82.1	-	82.7	71.9		-	64.4	-	59.4	[illegible]	-
10	-	63.0	58.1	54.3	-	-	-	81.[illegible]	-	75.7	71.3	-	-	65.8	-	62.1	53.2	-
11	-	-	62.7	65.5	-	-	-	72.3	-	64.9	52.9		-	56.8	-	50.1	55.0	-
12	-	61.0	-	54.5	-	-	-	65.0	-	54.8	47.9	-	-	65.6	-	64.5	68.7	
13	-	62.2	-	63.4	64.5	-	-	65.0	-	58.4	51.8	-	-	68.2	-	60.7	56.6	-
14	-	60.7	-	59.3	46.4	-	-	64.2	-	62.3	55.6	-	-	64.5	-	67.1	68.2	-
15	-	70.7	-	62.6	50.6	-	-	70.8	-	63.9	57.6	-	-	73.6	-	69.0	73.9	-
16	-	72.2	-	58.3	47.5	-	-	70.0	-	63.7	53.7	-	-	74.5	-	73.1	80.2	-
17	-	71.1	-	64.4	68.2	-	-	71.3	-	71.9	66.3	-	-	69.6	-	70.8	73.1	-
18	-	55.5	-	58.6	43.5	-	-	60.1	-	58.8	55.0	-	-	67.3	-	71.3	74.4	-
19	-	78.9	-	71.9*	70.5	-	-	81.1	-	71.3	69.1	-	-	65.3	-	67.7	61.8	-
20	-	74.0	-	72.6	71.7	-	-	82.6	-	77.5	63.1	-	-	50.8	-	54.4	54.1	-
21	-	47.5	-	63.6	50.5	-	-	57.3	-	67.5	70.4	-	-	45.8	-	62.2	53.5	
22	-	47.5	-	51.5	43.5	-	-	56.1	-	56.3	48.3	-	-	46.6	-	53.9	42.9	-
23	-	50.0	-	46.8	42.5	-	-	50.2	-	44.0	40.7	-	-	60.1	-	60.8	63.8	-
24	-	46.1		44.4	39.4	-	-	[illegible]	-	73.5	66.5	-	-	59.2	-	[illegible]	[illegible]	-
[illegible]	-	[illegible]	-	[illegible]	-	-	-	[illegible]	-	[illegible]	[illegible]	-		71.4		[illegible]	[illegible]	-

TABLE A-5. MEASURED [illegible] AND DNL VALUES**

Day / Hr Site	Thursday, 15 June 1978						Friday, 16 June 1978						Saturday, 17 June 1978					
	1	2	3	202	203	4	1	2	3	202	203	4	1	2	3	202	203	4
1	-	64.4	-	64.8	71.1	-	-	60.7	-	-	58.5	45.6	-	50.1	-	-	47.6	45.2
2	-	60.4	-	47.7	47.9	-	-	64.7	-	-	71.9	46.6	-	49.0	-	-	42.7	44.5
3	-	40.5	-	38.5	38.5	-	-	71.3	-	-	65.9	41.8	-	45.9	-	-	41.9	43.5
4	-	66.0	-	67.3	67.5	-	-	60.7	-	-	67.5	40.9	-	41.4	-	-	41.5	40.5
5	-	64.3	-	64.8	68.0	-	-	44.5	-	-	44.7	39.0	-	41.3	-	-	42.4	38.2
6	-	46.8	-	44.1	42.9	-	-	48.1	-	-	48.9	52.7	-	49.1	-	-	46.7	46.6
7	-	47.2	-	49.5	48.9	-	-	57.6	-	-	50.7	42.3	-	51.5	-	-	47.3	48.7
8	-	81.9	-	80.5	61.5	-	-	78.3	-	-	77.7	41.2	-	59.1	-	-	44.5	40.5
9	-	54.8	-	52.8	51.2	-	-	-	-	-	42.6	44.4	-	57.2	-	-	44.7	57.5
10	-	57.8	-	57.7	63.0	-	-	-	-	-	56.3	48.4	-	65.6	-	-	47.8	49.1
11	-	65.8	-	-	64.8	-	-	68.5	-	-	70.4	56.9	-	54.8	-	-	52.3	46.2
12	-	66.8	-	-	68.4	-	-	70.4	-	-	73.2	50.9	-	64.5	-	-	72.3	46.4
13	-	56.2	-	-	49.5	43.0	-	74.5	-	-	77.5	51.5	-	57.6	-	-	64.5	57.2
14	-	60.0	-	-	64.2	46.5	-	69.1	-	-	74.0	60.3	-	65.2	-	-	51.1	47.4
15	-	55.5	-	-	55.4	41.1	-	72.9	-	-	77.7	58.4	-	65.2	-	-	69.6	64.0
16	-	65.4	-	-	73.0	69.3	-	72.1	-	-	78.9	65.9	-	69.2	-	-	73.0	49.4
17	-	68.5	-	-	74.7	60.4	-	65.8	-	-	68.3	50.7	-	63.3	-	-	56.4	40.9
18	-	61.6	-	-	69.2	41.9	-	64.1	-	-	64.1	45.0	-	59.1	-	-	51.6	39.6
19	-	74.1	-	-	75.5	69.6	-	68.1	-	-	73.2	52.5	-	55.6	-	-	54.9	44.6
20	-	50.2	-	-	62.4	63.0	-	55.8	-	-	56.8	37.6	-	52.1	-	-	56.7	39.4
21	-	48.0	-	-	55.7	45.5	-	65.4	-	-	67.5	47.8	-	50.5	-	-	57.6	48.5
22	-	68.7	-	-	66.8	57.7	-	68.6	-	-	55.1	51.1	-	51.7	-	-	45.5	50.6
23	-	65.2	-	-	69.1	51.0	-	62.8	-	-	65.2	48.6	-	52.5	-	-	43.5	49.4
24	-	68.6	-	-	71.7	47.5	-	51.1	-	-	43.4	46.2	-	51.9	-	-	49.9	47.9
DNL	-	72.5	-	-	73.5	-	-	72.2	-	-	74.3	56.8	-	61.7	-	-	63.6	55.1
LEQ	-	69.9	-	-	68.1	-	-	69.3	-	-	71.9	54.9	-	[illegible]	-	-	[illegible]	52.8

**Calibration correction applied

[illegible] Site	[illegible]						[illegible] June 1979						[illegible] June 1979					
	1	2	[illegible]	202	[illegible]	4	1	2	[illegible]	[illegible]	203	4	1	2	[illegible]	[illegible]	[illegible]	[illegible]
1	-	44.7	-	-	42.3	47.3	-	43.5	-	-	42.0	49.5	-	65.2	-	-	66.7	49.8
2	-	43.4	-	-	44.7	46.7	-	45.4	-	-	41.7	47.2	-	64.6	-	-	67.8	50.6
3	-	46.8	-	-	52.4	47.0	-	47.7	-	-	45.4	50.9	-	43.1	-	-	41.8	48.1
4	-	41.3	-	-	43.2	45.8	-	43.6	-	-	43.8	45.7	-	64.4	-	-	72.2	47.1
5	-	41.8	-	-	45.5	44.9	-	41.3	-	-	44.9	41.3	-	43.2	-	-	48.0	42.9
6	-	55.1	-	-	40.7	46.7	-	66.6	-	-	68.1	60.8	-	41.8	-	-	43.5	49.6
7	-	52.7	-	-	40.2	46.6	-	70.2	-	-	72.2	67.0	-	47.2	-	-	52.7	44.7
8	-	58.3	-	-	38.1	42.2	-	71.4	-	-	70.9	68.5	-	52.9	-	-	43.8	42.0
9	-	63.8	-	-	38.5	41.4	-	46.2	-	-	42.6	44.7	-	60.3	-	-	55.3	45.2
10	-	56.5	-	-	43.4	36.7	-	52.7	-	-	56.8	51.0	-	65.5	-	-	66.0	58.7
11	-	54.8	-	-	53.4	45.2	-	58.5	-	-	51.6	51.4	-	75.7	-	-	61.7	49.2
12	-	61.9	-	-	53.1	44.9	-	65.1	-	-	65.6	57.9	-	57.8*	-	-	56.4	44.5
13	-	53.1*	-	-	51.8	53.7	-	63.8	-	-	68.3	45.7	-	70.4	-	-	71.6	56.9
14	-	52.5	-	-	54.2	45.0	-	58.5	-	-	49.5	44.9	-	63.4	-	-	67.0	50.6
15	-	53.7	-	-	58.6	42.9	-	68.3	-	-	75.7	70.4	-	66.8	-	-	72.0	50.4
16	-	48.6	-	-	43.7	43.5	-	66.4	-	-	73.9	50.6	-	58.0	-	-	55.6	54.1
17	-	60.2	-	-	59.8	40.2	-	53.7	-	-	58.4	46.1	-	57.9	-	-	55.9	47.9
18	-	57.3	-	-	48.8	47.8	-	53.4	-	-	45.0	47.2	-	55.1	-	-	56.3	38.5
19	-	59.0	-	-	48.6	51.8	-	61.9	-	-	56.3	74.0	-	58.3	-	-	59.4	60.0
20	-	61.9	-	-	55.5	42.3	-	54.7	-	-	46.5	39.7	-	46.0	-	-	46.9	42.9
21	-	56.4	-	-	49.1	52.4	-	50.2	-	-	53.5	47.7	-	51.8	-	-	52.8	53.7
22	-	46.9	-	-	42.9	52.8	-	65.7	-	-	74.9	62.3	-	55.9	-	-	62.7	54.5
23	-	45.5	-	-	44.6	50.8	-	70.1	-	-	72.3	64.1	-	60.3	-	-	64.9	61.6
24	-	43.8	-	-	48.9	49.6	-	63.9	-	-	68.5	50.4	-	65.5	-	-	71.1	63.1
ONL	-	58.6	-	-	54.8	54.7	-	71.2	-	-	73.9	67.6	-	69.2	-	-	73.0	62.5
[illegible]	-	56.7	-	-	51.7	48.1	-	64.4	-	-	68.4	63.6	-	65.1	-	-	65.7	54.9

*Reconstructed from valid SEL values

**Calibration corrected [illegible]

TABLE A-[illegible] MEASURED [illegible] AND DNL VALUES**

Day	Wednesday, 21 June 1978						Thursday, 22 June 1978											
Hr Site	1	2	3	202	203	4	1	2	3	202	203	4		2				
1	-	68.2	-	-	70.5	60.5	-	-	-	-	-	52.8						
2	-	64.4	-	-	74.9	57.2	-	-	-	-	-	51.7						
3	-	55.9	-	-	44.3	49.0	-	-	-	-	-	50.2						
4	-	43.9	-	-	45.6	48.3	-	-	-	-	-	48.9						
5	-	43.8	-	-	46.5	58.8	-	-	-	-	-	48.5						
6	-	61.5	-	-	71.1	52.3	-	-	-	-	-	47.7						
7	-	48.8	-	-	54.4	41.7	-	-	-	-	-	41.6						
8	-	61.9	-	-	49.0	42.5	-	-	-	-	-	43.7						
9	-	59.6	-	-	53.3	49.6	-	-	-	-	-	43.6						
10	-	62.4	-	-	53.1	46.2	-	-	-	-	-	-						
11	-	63.0	-	-	47.9	48.9	-	-	-	-	-	-						
12	-	64.2	-	-	58.3	47.7	-	-	-	-	-	-						
13	-	63.4	-	-	61.4	57.4	-	-	-	-	-	-						
14	-	67.9	-	-	74.8	65.5	-	-	-	-	-	-						
15	-	68.7	-	-	70.8	69.0	-	-	-	-	-	-						
16	-	57.6	-	-	-	52.5	-	-	-	-	-	-						
17	-	-	-	-	-	61.5	-	-	-	-	-	-						
18	-	-	-	-	-	38.3	-	-	-	-	-	-						
19	-	-	-	-	-	53.1	-	-	-	-	-	-						
20	-	-	-	-	-	39.5	-	-	-	-	-	-						
21	-	-	-	-	-	66.5	-	-	-	-	-	-						
22	-	-	-	-	-	62.4	-	-	-	-	-	-						
23	-	-	-	-	-	55.4	-	-	-	-	-	-						
24	-	-	-	-	-	60.9	-	-	-	-	-	-						
DNL	-	-	-	-	-	64.2	-	-	-	-	-	-						
LEQ	-	-	-	-	-	60.1	-	-	-	-	-	-						

**Calibration correction applied

$$L_h = 10 \log \sum_p 10^{\frac{L_{AE}}{10}} - 10 \log(3600) \qquad (1)$$

where

L_h = hourly noise level (HNL), dB

L_{AE} = A-Weighted Sound Exposure Level (SEL), dB

p = summation index for SEL values in particular hour.

The day-night noise levels for those situations were then calculated from the hourly noise levels as follows:

$$L_{dn} = 10 \log \sum_i 10^{\frac{L_h}{10}} + 10 \log \sum_j 10^{\frac{(L_h+10)}{10}} - 10 \log(24) \qquad (2)$$

where

L_{dn} = day-night noise level (DNL), dB

L_h = hourly noise level (HNL), dB

i = summation index for daytime HNL's

j = summation index for nighttime HNL's.

In addition, the average sound levels were calculated from the HNL and DNL values for each complete day of data and are also listed. If all 24 HNL values were available, the particular LEQ value was calculated using Eq. (3).

$$L_{24} = 10 \log \left[\sum_i 10^{\frac{L_h}{10}} + \sum_j 10^{\frac{L_h}{10}} \right] - 10 \log(24)$$

where

L_{24} = twenty-four-hour average noise level (LEQ), dB

L_h = hourly noise level (HNL), dB

i = summation index for daytime HNL's

j = summation index for nighttime HNL's.

If one or more daytime hourly noise levels were missing and all nighttime hourly noise levels were recorded, the LEQ was calculated using Eq. (4).

$$L_{24} = 10 \log \left[10^{\frac{L_{dn}}{10}} - \sum_{j} 10^{\frac{9(L_h+10)}{10}} \right] \quad (4)$$

where

L_{24} = twenty-four-hour average noise level (LEQ), dB

L_{dn} = day-night noise level (DNL), dB

L_h = hourly noise level (HNL), dB

j = summation index for nighttime HNL's.

Inspection of the data in Table A-6 reveals missing HNL values. The missing HNL values at sites 2 and 3 on June 6-7 are due to the paper jam caused by installing the portable noise level monitor units over backwards against trees. On other occasions, HNL values were not printed because the unit was being recalibrated.

SUMMARY OF FIELD TEST DAILY FLIGHT OPERATIONS

Next, the daily flight operations statistics were summarized from the tower log sheets. The log sheet for the end of 7 June with totals of that day's operations over the measurement sites is presented as Table A-7. These totals of each day's operations were summarized in Tables A-8(a), (b), and (c) for approaches, takeoffs, and patterns, respectively. In each case, summaries were made for both heavy aircraft and all aircraft. Equivalent numbers of daytime operations were then computed by multiplying the numbers of nighttime operatons by 10 and adding to the numbers of daytime operations. In Tables A-8(c) and A-8(b), the reversing of the direction of flights from Runway 14 (approaches over the measurement sites) to Runway 32 (takeoffs over the measurement sites) is apparent.

CALCULATION OF DAILY CORRECTIONS FOR AIRCRAFT OPERATIONS

If the daily proportion of takeoffs and landings are similar to the annual average, it is possible to adjust the daily DNL values based on equation 5.

AIRCRAFT TOWER LOG AND NOISE
MONITOR DATA TABULATION FORM

Installation [illegible]
Date 7 [illegible]
Runway(s) [illegible]

TABLE A-7

Aircraft Type								Operation		Time		Noise Monitor Data			
KC 135A	B 52 G	A-37	T-37	T-38	T-39	C-130	Other	Apprch*	T/O+	GMT	Local	Time	SEL, dB	Dur, sec	Max, dB
							C-150	IN		0020	1920				
✓								IN		0035	1935				
✓									OUT	0056	1956				
							C-150		OUT	0105	2005				
							C-150		OUT	0112	2012				
							C-150	P	P	0150	2050				
							C-150	P	P	0155	20[illegible]				
							C-150	P	P	0202	2102				
							C-150	IN		0203	2103				
							C-150	IN		0208	2108				
					✓			IN		0328	2228				
					✓				OUT	[illegible]	2300				
0	0	11	2	0	0	11	1	25	—	DAY	APPROACH		OVER NORTHERN MEASUREMENT SITE		
2	7	0	0	0	0	1	0	10	—	NIGHT					
28	15	27	0	0	2	21	17	—	93	DAY	TAKEOFF				
0	0	0	0	0	1	0	0	—	1	NIGHT					
13[illegible]	12	←		93	→			123.5		DAY	PATTERN		OVER EAST RESERVATION		
1	6.5	←		16	→			23.5		NIGHT					
								TOTALS							

*Approach - SI - Straight In
P - Pattern

+Takeoff SO - Straight Out
P - Pattern

R - Right Turn Departure
L - Left Turn Departure

TABLE A-8(a) DAILY OPERATIONS SUMMARY, APPROACHES OVER THE NORTHERN MEASUREMENT SITES

Day	Date	KC-135A		B-52G		Total Heavy A/C		Equivalent Day Heavy A/C	Other A/C		Total A/C		Equivalent Day A/C
		Day	Night	Day	Night	Day	Night		Day	Night	Day	Night	
T	6 June 78*	0	1	5	0	5	1	15	15	0	20	1	30
W	7	0	2	0	7	0	9	90	25	1	25	10	125
Th	8	-	-	-	-	-	-	-	-	-	-	-	-
F	9	-	-	-	-	-	-	-	-	-	-	-	-
S	10	9	0	0	0	9	0	9	64	2	73	2	93
S	11	7	0	0	0	7	0	7	30	0	37	0	37
M	12	11	0	0	0	11	0	11	35	2	46	2	66
T	13	-	-	-	-	-	-	-	-	-	-	-	-
W	14	30	1	22	1	52	2	72	120	0	172	2	192
Th	15	17	21	11	5	28	26	288	116	0	144	26	404
F	16	39	20	31	11	70	31	380	84	0	154	31	464
S	17	6	0	13	0	19	0	19	38	4	57	4	97
S	18	0	0	0	0	0	0	0	52	3	52	3	82
M	19	18	26	14	4	32	30	332	104	0	136	30	436
T	20 *	-	-	-	14	-	14	140	-	2	-	16	160
W	21												
Th	22												

*Partial Day

TABLE A-8 (b) DAILY OPERATIONS SUMMARY, TAKEOFFS OVER THE NORTHERN MEASUREMENT SITES

Day	Date	KC-135A		B-52G		Total Heavy A/C		Equivalent Day Heavy A/C	Other A/C		Total A/C		Equivalent Day A/C
		Day	Night	Day	Night	Day	Night		Day	Night	Day	Night	
T	6 June 78 *	-	-	-	-	-	-	-	-	-	-	-	-
W	7	28	0	15	0	43	0	43	48	1	93	1	103
Th	8	11	9	18	7	29	16	189	164	9	193	25	443
F	9	29	0	25	3	54	3	84	112	3	166	6	226
S	10	0	0	0	0	0	0	0	0	1	0	1	10
S	11	-	-	-	-	-	-	-	-	-	-	-	-
M	12	7	3	18	0	25	3	55	75	1	100	4	140
T	13	14	6	23	11	37	17	207	134	18	171	35	521
W	14	2	5	3	12	5	17	175	9	2	14	19	204
Th	15	-	-	-	-	-	-	-	-	-	-	-	-
F	16	-	-	-	-	-	-	-	-	-	-	-	-
S	17	-	-	-	-	-	-	-	-	-	-	-	-
S	18	-	-	-	-	-	-	-	-	-	-	-	-
M	19	-	-	-	-	-	-	-	-	-	-	-	-
T	20*	-	-	-	-	-	-	-	-	-	-	-	-
W	21												
Th	22												

* Partial day

TABLE A-8 (c) DAILY OPERATIONS SUMMARY, PATTERNS OVER THE EAST RESERVATION MEASUREMENT SITES

Day	Date	KC-135A		B-52G		Total Heavy A/C		Equivalent Day Heavy A/C	Other A/C		Total A/C		Equivalent Day A/C
		Day	Night	Day	Night	Day	Night		Day	Night	Day	Night	
T	6 June 78*	1	0	1	0	2	0	2	5	0	7	0	7
W	7	18.5	1	12	6.5	30.5	7.5	105.5	93	16	123.5	23.5	358.5
Th	8	7	0	11	0	18	0	18	90	7	108	7	178
F	9	23	0	25	3	48	3	78	70	0	118	3	148
S	10	4	0	0	0	4	0	4	43	0	47	0	47
S	11	4	0	0	0	4	0	4	2	0	6	0	6
M	12	12	3	15	0	27	3	57	80	2	137	5	187
T	13	10	2	15	10	25	12	145	93	12	118	24	358
W	14	22	4	15	12	37	16	197	61	0	98	16	258
Th	15	2	23	8	7	10	30	310	37	11	47	41	457
F	16	32	19	26	10	58	29	248	38	0	96	29	386
S	17	3	0	11	0	14	0	14	23	0	37	0	37
S	18	0	0	0	0	0	0	0	15	1	15	1	25
M	19	15	24	11	3	26	27	296	68	0	94	27	364
T	20*	-	0	-	12	-	12	120	-	2	-	14	140
W	21												
Th	22												

*Partial Day

$$\Delta = 10 \log \frac{\text{Number NOISEMAP Equiv Average Day Operations}}{\text{Number Field Test Equiv Day Operations}}$$

Typically the ratio of takeoffs and landings vary from day to day. Measurement at the same location for an extended period of time will normally provide average operational data that has a ratio similar to the annual average operational data. During the field measurements at Barksdale, one location was measured throughout the study. This was site 2. Corrections for all aircraft and for heavy aircraft are shown in Table A-9.

APPLICATION OF AIRCRAFT OPERATIONS CORRECTIONS TO MEASURED DNL VALUES

The corrections for the number of aircraft operations were applied to the measured DNL values in Table A-10 for total aircraft volume and for heavy aircraft volume. The energy average and sample standard deviations were calculated. This calculation was performed on a hand calculator with statistical functions. In equation form, the energy average DNL value for a specific site is given by

$$\overline{L_{dn}} = 10 \log \frac{1}{n} \sum_{\ell} 10^{\frac{L_{dn}}{10}}$$

where

$\overline{L_{dn}}$ = energy average day-night noise level (DNL), dB

n = number of DNL values measured at the specific site

L_{dn} = individual day-night noise level (DNL), dB

ℓ = summation index for DNL values.

Note that in all subsequent calculations involving sets of data, the symbol "n" is used to represent the number of data values involved in the particular calculation.

Table A-9 Flight Operations Corrections

Day of Week	Date	All Aircraft Over Site 2 App	All Aircraft Over Site 2 T/O	All Aircraft Over Site 2 Total	Heavy Aircraft Over Site 2 App	Heavy Aircraft Over Site 2 T/O	Heavy Aircraft Over Site 2 Total
W	7 June 1978	125	103	228	90	43	133
Th	8	0	443	443	0	189	189
F	9	0	226	226	0	84	84
S	10	93	10	103	9	0	9
S	11	37	0	37	7	0	7
M	12	66	140	206	11	55	66
T	13	0	521	521	0	207	207
W	14	192	204	396	72	175	247
Th	15	404	0	404	288	0	288
F	16	464	0	464	380	0	380
S	17	97	0	93	19	0	19
S	18	82	0	82	0	0	0
M	19	436	0	436	332	0	332
Average Daily Flight	All Days	154	127	281	93	58	151
	Week Days	174	182	356	130	84	224
NOISEMAP	-	197	132	329	104	70	174
Correction Δ, dB	All Days			.7			.6
	Week Days			-.3			-1.1

Table A-10 Application of Corrections to Measured DNL Values - Site 2

Day of Week	Date	Measured DNL Values
W	7 June 1978	73.9
Th	8	74.4
F	9	75.8
S	10	55.7
S	11	56.5
M	12	68.4
T	13	76.4
W	14	71.4
Th	15	72.5
F	16	72.2
S	17	61.7
S	18	58.6
M	19	71.2
Energy Average DNL (dB)	All Days	72.0
	Week Days	73.5
Energy Average Standard Deviation	All Days	+2.8/-10.6
	Week Days	+1.9/-3.4

		All Aircraft	Heavy Aircraft
Correction Δ, dB	All Days	.7	.6
	Week Days	-.3	-1.1
Corrected Energy Average DNL	All Days	72.7	72.6
	Week Days	73.2	72.4
NOISEMAP DNL (Ref)		76.4	76.4

The average DNL estimates based on both weekdays' and all-days' measurements are given in Table A-10 along with the corresponding NOISEMAP predictions. The estimates based on the field measurements are lower than the NOISEMAP predictions.

With only the use of measured DNL data, these differences in measurements and predictions cannot be resolved.

The DNL sample standard deviation values were calculated on the basis on energy at the same time the energy average values were determined (with the hand-held calculator) using the relationship

$$s^2 = \frac{1}{n - 1}\left[\sum_{\ell}\left(10^{\frac{L_{dn}}{10}}\right)^2 - n\left(10^{\frac{\overline{L_{dn}}}{10}}\right)^2\right] \tag{7}$$

where

s = sample standard deviation expressed as an antilog with 1.0 equal to the sound level reference of 20μ N/n^2

n = number of DNL values in sample.

The energy standard deviation was first added to and then subtracted from the energy mean value. These values were then converted to dB, the mean DNL value was subtracted and the standard deviation in terms of dB was thus calculated.

ANALYSIS USING MEASURED SEL VALUES

CORRELATION OF RECORDED SEL'S WITH TOWER LOGS

A Noise Monitor Data Tabulation Form Extension was added to each page of the tower flight log. The SEL events recorded on the portable noise level monitor units were correlated with tower flight log events, and the recorded data were tabulated. A tabulation for one day, 7 June 1978, is presented as Table A-11. This tabulation is a laborious task which was facilitated by employing the following steps:

TABLE A-11

AIRCRAFT TOWER LOG AND NOISE MONITOR DATA TABULATION FORM

NOISE MONITOR DATA TABULATION FORM EXTENSION, THREE SITES

Installation BAFB
Date 2 June 76
Runway(s) 14

Aircraft Type: KC 135A	B 52 G	A-37	T-37	T-38	T-39	C-130	Other	Operation: Apprch*	I/O†	Time: GMT	Local	Time: Site 1	Site 2	Site 3	SEL, dB: Site 1	Site 2	Site 3	Δ 1-2	Δ 3-2	Duration, sec.: Site 1	Site 2	Site 3	MAX, dB: Site 1	Site 2	Site 3
						✓		SI		0502	0002	000201	000148	—	90.0	81.1	—	3.9	—	23	24.1	—	92.9	70.7	—
✓								P	P	0510	0010	001110	001106	—	89.9	77.9	—	12	—	70	25	—	79.3	67.2	—
✓								SI		0518	0018	001704	001656	—	101.6	94.5	—	7.1	—	46	49	—	92.2	95.1	—
						✓			SO	0520	0020														
	✓							P	P	0815	0315	031317	031310	—	105.5	100.7	—	4.8	—	53	51	—	97.9	91.2	—
	✓							P	P	0818	0318														
	✓							P	P	0826	0326	032525	032514	—	102.9	96.1	—	6.8	—	52	41	—	94.4	85.8	—
	✓							P	P	0836	0336	033507	033448	—	90.9	76.8	—	14.1	—	41	16	—	81.3	68.4	—
	✓							P	P	0847	0347	034615	034558	—	100.7	89.7	—	11	—	43	40	—	92.3	80.1	—
	✓							P	P	0851	0351	035123	035120	—	88.4	74.8	—	13.6	—	23	12	—	79.5	67.1	—
	✓							P		0858	0358	035716	035710	—	92.1	77.8	—	14.3	—	46	24	—	80.7	67.4	—
					✓				SO	1056	0556														
						✓		P	P	1241	0741	074052	074041	—	92.0	82.2	—	9.8	—	22	24	—	85.7	71.8	—
	✓								SO	1245	0745														
						✓		P	P	1256	0756	075540	075530	—	92.1	91.6	—	10.5	—	25	28	—	84.8	70.5	—
						✓		P		1310	0810	080923	—	—	79.4	—	—	—	—	19	—	—	71.3	—	—
	✓								SO	1316	0816														
✓									SO	1317	0817														
		✓							SO	1328	0828														
		✓							SO	1329	0829														
							F-5		SO	1331	0831														
						✓			SO	1335	0835														
		✓							P	1337	0837														
						✓		P	P	1342	0842	084148	094143	—	87.7	83.0	—	4.7	—	23	28	—	79.2	74.2	—
			✓					P	P	1345	0845														
			✓					SI		1347	0847														
						✓		P	P	1348	0848	094805	084810	—	86.9	73.3	—	13.6	—	23	8	—	79.9	65.3	—
			✓						SO	1350	0850														
						✓		P	P	1354	0854	085331	—	—	78.8	—	—	—	—	16	—	—	70.6	—	—
			✓						SO	1356	0856														

*Approach SI Straight In, P Pattern †Takeoff SO Straight Out, P Pattern, R Right Turn Departure, L Left Turn Departure

AIRCRAFT TOWER LOG AND NOISE
MONITOR DATA TABULATION FORM

TABLE A-11

NOISE MONITOR DATA TABULATION FORM EXTENSION, THREE SITES

Installation: [illegible]
Date: 7 Jun 76
Runway(s): 14 (32)

KC 135A	B 52 G	A-37	T-37	T-38	T-39	C-130	Other	Operation Apprch*	Operation T/O†	Time GMT	Time Local	Time Site 1	Time Site 2	Time Site 3	SEL, dB Site 1	SEL, dB Site 2	SEL, dB Site 3	Δ 1-2	Δ 3-2	Duration, sec. Site 1	Duration, sec. Site 2	Duration, sec. Site 3	MAX, dB Site 1	MAX, dB Site 2	MAX, dB Site 3
		✓						P	P	1358	0858	085721	—	—	92.5	—	—	—	—	42	—	—	83.5	—	—
						✓		P	P	1359	0859	085954	—	—	82.9	—	—	—	—	36	—	—	72.2	—	—
		✓						P	P	1403	0903	090209	—	—	96.7	—	—	—	—	35	—	—	92	—	—
						✓		P	P	1405	0905	090501	—	—	89.6	—	—	—	—	23	—	—	82.2	—	—
		2							SO(2)	1407	0907	090627	—	—	91.8	—	—	—	—	32	—	—	84.4	—	—
		✓						P	P	1408	0908	090814	—	—	79.2	—	—	—	—	33	—	—	67.5	—	—
		✓							SO	1410	0910														
							C-9		SO	1411	0911														
		✓						P	P	1412	0912	—	—	—	—	—	—	—	—	—	—	—	—	—	—
						✓		P	P	1413	0913	091335	—	—	79.7	—	—	—	—	21	—	—	69.3	—	—
		✓						P	P	1418	0918	091754	—	—	86.5	—	—	—	—	17	—	—	79.2	—	—
		✓						P	P	1425	0925	—	—	—	—	—	—	—	—	—	—	—	—	—	—
						✓		P	P	1427	0927	092719	—	—	88.9	—	—	—	—	22	—	—	81.2	—	—
		✓						P	P	1430	1930	092850	—	—	88.1	—	—	—	—	27	—	—	79.5	—	—
							C131	SI		1432	0932	093032	—	—	82.3	—	—	—	—	22	—	—	73.4	—	—
		2						P(2)	P(2)	1439	0939	093909	—	—	94.2	—	—	—	—	30	—	—	86.8	—	—
						✓		P	P	1441	0941	094143	—	—	90.3	—	—	—	—	26	—	—	83.5	—	—
			✓						SO	1443	0943														
		✓						P	P	1445	0945	094423	—	—	84.6	—	—	—	—	21	—	—	76.1	—	—
		✓						P	P	1448	0948	094747	—	—	86.7	—	—	—	—	29	—	—	78.4	—	—
		✓							OUT	1450	0950														
CHANGE TO RUNWAY 32																									
		2						P(2)	P(2)	1454	0954	095631	—	—	81.7	—	—	—	—	24	—	—	73.0	—	—
						✓		P	P	1456	0956	095949	—	—	88.1	—	—	—	—	54	—	—	74.5	—	—
		✓						SI		1459	0959														
		✓						P	P	1502	1002	—	—	—	—	—	—	—	—	—	—	—	—	—	—
						✓			OUT	1506	1006	—	—	100800	—	—	76.2	—	—	—	—	9	—	—	76.2
		2						SI(2)		1509	1009														
		✓						SI		1513	1013														
		✓						SI		1514	1014														

*Approach - SI - Straight In
P - Pattern

†Takeoff SO - Straight Out
P - Pattern

R - Right Turn Departure
L - Left Turn Departure

AIRCRAFT TOWER LOG AND NOISE MONITOR DATA TABULATION FORM

TABLE A-11

NOISE MONITOR DATA TABULATION FORM EXTENSION, THREE SITES

Installation: BAFB
Date: 7 June 78
Runway(s): 32

Aircraft Type: KC 135A	B 52 G	A-37	T-37	T-38	T-39	C-130	Other	Operation: Apprch*	I/O+	Time: GMT	Local	Time: Site 1	Site 2	Site 3	SEL, dB: Site 1	Site 2	Site 3	Δ 1-2	Δ 3-2	Duration, sec.: Site 1	Site 2	Site 3	MAX, dB: Site 1	Site 2	Site 3
						✓		P	P	1516	1016	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		✓						P	P	1518	1018	101835	101843	101839	87.5	76.1	70.7	11.4	-5.4	26	15	7	79.6	67.0	65.1
						✓		P	P	1520	1020	102324	—	102320	90.1	—	87.3	—	—	17	—	35	71.5	—	77.2
		✓						IN		1521	1021														
							C-140		OUT	1523	1023	—	—	102534	—	—	74.0	—	—	—	—	13	—	—	64.9
						✓		P	P	1524	1024	102618	—	102632	100.7	—	85.6	—	—	49	—	52	91.4	—	74.2
						✓		P	P	1527	1027	102936	—	—	90.5	—	—	—	—	22	—	—	83.5	—	—
	✓								OUT	1529	1029	103215	103223	103236	116.3	109.4	102.1	6.9	-7.3	80	92	98	106.7	99.0	92.8
						✓		P	P	1531	1031	103336	—	103342	81.8	—	66.2	—	—	22	—	4	73.1	—	60.8
		✓						IN		1533	1033														
						✓		P	P	1534	1034	103601	—	—	82.4	—	—	—	—	20	—	—	74.4	—	—
						✓		P	P	1537	1037	104002	—	—	82.8	—	—	—	—	20	—	—	73.9	—	—
						✓		P	P	1540	1040	104236	104237	104239	87.5	74.1	67.5	13.4	-6.6	21	13	4	79.5	66.3	62.3
						✓		P	P	1545	1045	104640	104643	104647	85.3	74.1	72.9	11.2	-1.2	20	14	12	78.2	65.5	64.8
						✓		P	P	1547	1047	104949	104956	105008	86.6	89.2	72.6	-2.6	-9.6	23	23	21	78.5	81.5	68.8
						✓		P	P	1600	1100	110257	110305	110308	86.5	87.7	77.8	-1.2	-9.9	21	22	21	78.9	79.3	68.9
						✓		P	P	1629	1124	—	—	—	—	—	—		—	—	—	—	—	—	—
						✓		P	P	1634	1134	113605	113635	—	72.2	70.4	—		—	14	5	—	65.4	63.7	
					✓				OUT	1636	1136	113724	113727	113733	94.6	95.9	87.2		-8.7	36	40	40	86.1	86.7	77.7
✓									OUT	1637	1137	113854	113856	113857	115.1	115.0	106.7		-8.3	70	84	75	105.6	105.5	96.8
						✓		P	P	1645	1145	—	—	—	—	—	—		—	—	—	—	—	—	—
✓									OUT	1648	1148	115136	115145	115141	111.9	113.3	103.1		-10.2	65	82	81	102.4	103.2	90.6
						✓		P	P	1717	1217	122003	122033	12057	81.9	87.6	94.5		6.9	25	49	64	73.2	77.5	81.9
							2(H1)		OUT	1718	1218	—	—	—	—	—	—		—	—	—	—	—	—	—
		✓						P	P	1719	1219	122021	—	—	74.3	—	—		—	15	—	—	66.4	—	—
							C-150		OUT	1719	1219	—	—	—	—	—	—		—	—	—	—	—	—	—
						✓		P	P	1723	1223	—	—	—	—	—	—		—	—	—	—	—	—	—
		✓						P	P	1725	1225	122756	122750	122759	95.0	83.9	77.3	10.1	-6.6	37	32	23	85.4	72.8	69.1
✓								P	P	1728	1228	—	—	—	—	—	—	—	—	—	—	—	—	—	—
						✓		P	P	1730	1230	—	—	—	—	—	—	—	—	—	—	—	—	—	—

AIRCRAFT TOWER LOG AND NOISE MONITOR DATA TABULATION FORM

TABLE A-11

SITE MONITOR DATA TABULATION FORM EXTENSION, THREE SITES

Installation: BAFB
Date: 7 June 78
Runway(s): 32

Aircraft Type: KC-135A	B-52 G	A-37	T-37	T-38	T-39	C-130	Other	Operation: Apprch*	T/O†	Time: GMT	Local	Time: Site 1	Site 2	Site 3	SEL, dB: Site 1	Site 2	Site 3	Δ 1-2	Δ 3-2	Duration, sec.: Site 1	Site 2	Site 3	MAX, dB: Site 1	Site 2	Site 3
		✓						P	P	1731	1231	—	—	—	—	—	—	—	—	—	—	—	—	—	—
						✓		P	P	1733	1233	123611	123616	123609	87.3	77.4	70.1	9.9	-7.3	22	16	11	78.2	67.8	62.0
		✓						P	P	1734	1234	123709	—	—	74.8	—	—	—	—	11	—	—	68.0	—	—
		✓							OUT	1741	1241	124254	124302	124304	93.8	92.3	86.6	1.5	-5.7	44	42	42	84.1	81.8	76.8
✓									OUT	1742	1242	124450	124454	124505	105.5	108.5	102.1	-3.0	-6.4	63	58	55	95.7	98.6	96.0
		✓							OUT	1745	1245	124742	124753	—	84.1	79.1	—	5.0	—	25	27	—	74.5	68.5	—
		✓						P	P	1746	1246	124651	—	—	77.1	—	—	—	—	17	—	—	68.1	—	—
		✓							OUT	1751	1251	125409	125406	—	84.6	78.7	—	5.9	—	18	17	—	76.3	69.5	—
		✓						IN		1754	1254														
							C-150	IN		1758	1258														
		✓							P	1800	1300	—	—	130303	—	—	75.0	—	—	—	—	18	—	—	65.1
		✓						P	P	1803	1303	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		✓						IN		1805	1305														
					✓				P	1807	1307	—	—	130938	—	—	82.8	—	—	—	—	43	—	—	72.8
		✓								1809	1309														
		✓						IN		1810	1310														
		✓						IN		1815	1315														
		2							SO(2)	1817	1317	131954	131958	132015	99.4	96.0	90.6	3.4	-5.4	45	53	64	89.5	86.1	81.0
		2							SO(2)	1820	1320	132230	132235	132237	98.2	96.7	89.4	2.5	-7.3	49	49	53	90.1	86.4	77.9
							4H-5	IN		1823	1323														
✓								IN		1826	1326														
		✓						P	P	1830	1330	—	—	—	—	—	—	—	—	—	—	—	—	—	—
						✓			OUT	1834	1334	133550	—	—	79.2	—	—	—	—	21	—	—	70.6	—	—
✓									OUT	1842	1342	134258	134305	134312	107.7	112.8	106.0	-5.1	6.8	67	66	77	97.3	103.0	93.6
✓								P	P	1858	1358	134506	134513	134521	113.4	106.6	92.3	6.8	9.3	68	86	74	104.2	95.3	88.8
✓								P	P	1913	1413	141429	141430	141438	103.1	93.4	87.9	9.3	-5.5	76	66	57	92.0	88.5	77.4
		✓						P	P	1916	1416	141630	—	—	79.8	—	—	—	—	23	—	—	71.7	—	—
✓									OUT	1920	1420	142156	142155	142154	109.1	99.1	91.3	10.0	-7.8	58	-61	61	99.4	87.6	80.8
		✓						P		1921	1421														
✓								P		1927	1427														

*Approach: SI Straight In, P Pattern. †Takeoff: SO Straight Out, P Pattern, R Right Turn Departure, L Left Turn Departure

TABLE A-11

AIRCRAFT TOWER LOG AND NOISE MONITOR DATA TABULATION FORM

NOISE MONITOR DATA TABULATION FORM EXTENSION, THREE SITES

Installation BAFB
Date 7 June 78
Runway(s) 32

Aircraft Type: KC 135A	B 52 G	A-37	T-37	T-38	T-39	C-130	Other	Operation: Apprch*	I/O+	Time: GMT	Local	Time: Site 1	Site 2	Site 3	SFL, dB: Site 1	Site 2	Site 3	Δ 1-2	Δ 3-2	Duration, sec.: Site 1	Site 2	Site 3	MAX, dB: Site 1	Site 2	Site 3
		✓						P		1931	1931														
		✓						P	P	1933	1433	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		✓						P		1938	1438														
							T-34	IN		1940	1440														
✓									OUT	1944	1444	144540	144605	144547	97.2	87.7	85.5	8.5	-2.8	74	58	52	86.1	78.1	73.5
							DH5		OUT	1953	1453	145451	145455	—	78.1	74.3	—	3.8	—	20	13	-	67.6	64.6	—
✓								P	P	1958	1458	150052	150100	150101	107.7	93.1	86.8	6.6	-6.3	71	51	36	98.7	85.5	76.8
✓								P	P	2004	1504	150810	150817	150823	90.6	83.1	75.8	7.5	-7.3	48	40	21	81.2	73.5	66.3
✓								P	P	2007	1507	150943	150947	150954	95.1	85.9	74.8	9.3	-11	58	57	31	85.5	74.9	69.2
	✓							P	P	2009	1509	151058	151100	151131	106.1	97.1	89.0	11	-8.1	65	61	58	96.5	85.6	76.8
✓								P	P	2012	1512	151444	151507	151501	87.5	78.3	74.0	9.2	-4.3	44	15	15	76.8	69.5	64.8
✓								P	P	2018	1518	152104	152130	—	89.5	76.3	—	13.2	—	50	16	-	80.0	67.0	—
✓								P	P	2022	1522	152358	152425	152405	84.8	80.4	74.1	4.4	-6.3	43	32	8	73.4	69.9	68.8
	✓							P	P	2026	1526	152807	152806	152801	95.5	80.5	77.1	15	-3.4	49	16	21	87.6	72.1	66.0
✓								P	P	2027	1527	152556	152958	152954	91.9	86.3	94.1	6.6	7.8	45	44	38	83.6	74.9	98.9
✓								P	P	2033	1533	153639	—	—	82.1	—	—	—	—	34	-	-	71.9	—	—
✓								IN		2035	1535														
	✓							P	P	2040	1540	154232	154234	154238	96.7	84.5	82.0	12.2	-2.5	50	34	34	96.7	73.9	72.8
✓								P	P	2047	1547	154912	—	—	90.8	—	—	-	-	27	-	-	71.8	—	—
							PA28		P	2048	1548	—	—	—	—	—	—	—	—	—	—	—	—	—	—
✓								P		2052	1552														
	✓							IN		2054	1554														
							PA28	P		2056	1556														
✓									OUT	2101	1601	160304	—	160237	75.9	—	74.2	—	-	16	—	7	66.7	—	68.8
✓								P		2106	1606														
✓									P	2115	1615	161647	161644	161658	82.0	71.3	74.0	10.7	2.7	21	8	14	74.2	67.8	64.8
✓								IN		2120	1620														
	✓							IN		2134	1634														
	✓							P	P	2159	1659	170221	170229	170237	113.2	105.9	96.8	8.3	-9.1	71	50	55	106.1	96.4	86.5
✓								P	P	2209	1709	171059	171101	171100	92.4	82.0	81.9	10.4	-0.1	57	30	28	82.9	70.8	72.8

TABLE A-11

AIRCRAFT TOWER LOG AND NOISE MONITOR DATA TABULATION FORM

NOISE MONITOR DATA TABULATION FORM EXTENSION, THREE SITES

Installation BAFB
Date 7 June 78
Runway(s)

Aircraft Type: KC 135A	B 52 G	A-37	T-37	T-38	T-39	C-130	Other	Operation: Apprch*	I/O+	Time: GMT	Local	Time: Site 1	Site 2	Site 3	SEL, db: Site 1	Site 2	Site 3	Δ 1-2	Δ 3-2	Duration, sec.: Site 1	Site 2	Site 3	MAX, dB: Site 1	Site 2	Site 3
	✓							P	P	2213	1713	171518	171530	171535	112.9	103.5	93.0	9.4	-10.5	59	49	52	106.6	95.0	84.8
						✓		IN		2215	1715														
					✓			IN		2218	1718														
	✓							P	P	2220	1720	172234	172239	—	92.8	86.8	—	12	—	33	22	-	83.7	71.7	—
✓								P	P	2222	1722	172432	172438	172440	98.5	88.1	85.3	10.4	-2.8	74	50	36	87.2	77.5	77.3
							T-34		OUT	2224	1724	172625	172634	172639	71.9	70.0	78.1	1.9	8.1	9	7	10	63.2	63.1	72.8
	✓							P	P	2227	1727	172830	172834	—	85.7	76.2	—	10.5	—	27	10	-	77.6	70.0	—
							C-150		OUT	2230	1730	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	✓							P	P	2232	1732	173412	—	—	92.9	—	—	—	—	33	—	—	83.2	—	—
✓								P	P	2235	1735	173806	173810	173812	96.6	88.0	81.8	8.6	-6.2	71	39	31	86.9	77.9	72.8
	✓							P	P	2238	1738	174040	174049	174053	113.3	101.1	91.0	12.2	-10.1	60	44	40	106.4	92.0	82.4
							C-150		P	2241	1741	174139	—	—	78.5	—	—	—	—	22	—	—	71.4	—	—
							C-150	IN		2246	1746														
✓								P	P	2249	1749	175146	175157	175150	88.9	81.4	76.1	7.5	-5.3	36	25	19	78.8	71.2	65.5
	✓							P	P	2252	1752	175410	175422	175429	112.7	106.1	96.6	6.6	-9.5	70	52	49	104.8	96.6	86.5
✓								P	P	2255	1755	175706	175722	—	88.1	77.6	—	10.5	—	39	19	—	78.3	69.5	—
							C-150		OUT	2258	1758	—	—	—	—	—	—	—	—	—	—	—	—	—	—
							C-150		OUT	2259	1759	—	—	180149	—	—	65.4	—	—	—	—	5	—	—	60.8
✓								IN		2306	1806														
	✓							P	P	2307	1807	180840	180856	180859	100.8	91.6	86.2	9.2	-5.4	37	41	43	94.5	90.4	76.8
							L188	IN		2315	1815														
	✓								OUT	2318	1818	182018	182024	182032	115.9	113.2	104.1	2.7	-9.1	75	78	78.5	106.2	102.9	92.8
	✓							P	P	2322	1822	182441	182448	182448	104.0	92.3	87.3	11.7	-5	47	40	37	94.3	82.4	77.4
	✓								OUT	2325	1825	182812	182818	182824	116.0	113.8	102.3	2.2	-11.5	62	69	67	105.7	107.3	89.7
	✓							IN		2335	1835														
							C-150	IN		2338	1838														
							C-150	IN		2343	1843														
							C-150	IN		2358	1858														
							L188		OUT	0006	1906														
2									OUT	0010	1910	191259	191302	191300	121.4	113.7	103.3	7.7	-10.4	86	92	87	109.3	101.5	89.7

AIRCRAFT TOWER LOG AND NOISE MONITOR DATA TABULATION FORM

Table D-3

TABLE A-11

NOISE MONITOR DATA TABULATION FORM EXTENSION, THREE SITES

Installation BAFB
Date 7 June 78
Runway(s) 32

Aircraft Type: KC 135A	B 52 G	A-37	T-37	T-38	T-39	C-130	Other	Operation: Apprch*	Operation: T/O†	Time: GMT	Time: Local	Time: Site 1	Time: Site 2	Time: Site 3	SFL, dB: Site 1	SFL, dB: Site 2	SFL, dB: Site 3	SFL, dB: Δ 1-2	SFL, dB: Δ 3-2	Duration, sec.: Site 1	Duration, sec.: Site 2	Duration, sec.: Site 3	MAX, dB: Site 1	MAX, dB: Site 2	MAX, dB: Site 3
							C-150	IN		0020	1920														
✓								IN		0035	1935														
✓									OUT	0056	1956	195709	195718	195723	110.5	108.6	98.1	2.5	-9.9	85	84	78	101.0	97.8	84.8
							C-150		OUT	0105	2005	—	—	—	—	—	—	—	—	—	—	—	—	—	—
							C-150		OUT	0112	2012	—	—	—	—	—	—	—	—	—	—	—	—	—	—
							C-150	P	P	0150	2050	—	—	—	—	—	—	—	—	—	—	—	—	—	—
							C-150	P	P	0155	2056	—	—	—	—	—	—	—	—	—	—	—	—	—	—
							C-150	P	P	0202	2102	—	—	—	—	—	—	—	—	—	—	—	—	—	—
							C-150	IN		0203	2103														
							C-150	IN		0208	2108														
					✓			IN		0328	2228														
					✓				OUT	0400	2300	230141	230149	230148	91.2	81.2	73.5	10.0	-7.7	39	29	17	80.6	70.3	62.1
0	0	11	2	0	0	11	1	25	—	DAY		APPROACH		OVER NORTHERN MEASUREMENT SITE											
2	7	0	0	0	0	1	0	10		NIGHT															
23	15	27	0	0	2	21	17	—	93	DAY		TAKEOFF													
0	0	0	0	0	1	0	0	—	1	NIGHT															
115	12				93			123.5		DAY		PATTERN		OVER EAST RESERVATION											
1	6.5				16			23.5		NIGHT															
								TOTALS																	

- Checking for consistent time differences: The time delay between tower events and monitor unit events was approximately 2.5 minutes for takeoffs and approximately (-)1.0 minute for approaches. The difference in time delays is attributed to the logging procedure used in the tower. Takeoffs and approaches were listed in anticipation of passing in front of the tower. This relieved the tower personnel to concern themselves with the next operation instead of waiting after clearance to land or takeoff was given.

- On the first pass through the data, identifying only the loudest aircraft, in this case B-52G and KC-135A. The loudest aircraft are both the easiest to identify and the dominant contributors to average day DNL levels.

- Verifying that the SEL level and duration are both consistent with other results from the same type operation.

TABULATION AND AVERAGING OF SEL VELUES

Next, the SEL values were summarized by aircraft as shown in Table A-12. For the heavy aircraft, the SEL events were divided into four categories:

Straight-in Approaches
Pattern Approaches
Pattern Takeoffs
Straight-out Takeoffs.

For the smaller aircraft, the SEL events were divided into only two categories:

Approaches
Takeoffs.

In Table A-12, the SEL values for each type of aircraft operation are correlated from site to site. For example, the first entry for site 1, 102.9, is for the same straight-in KC-135A approach as the first entry for site 2, 99.6 dB. At site 3, the portable noise level monitor unit was not operational at that time because of the aforementioned paper jam. This bookkeeping technique is helpful in critiquing the results. In Table A-12, dashes represent events which did not

TABLE A-12 MEASURED SEL TABULATION FORM, SITE 1

	AC - KC 135A				AC - B52G				AC - A-37		AC - T-37		AC - T-38	
	Approach		T/O		Approach		T/O		Approach	T/O	Approach	T/O	Approach	T/O
	SI	Patt	Pat	SO	SI	Pat	Pat	SO						
	103.9	99.9	95.0	115.1	105.0	105.3	106.1	116.3	92.5	97.5	86.4	94.3	73.6	90.4
	101.6	95.9	113.4	111.9	108.8	102.9	95.5	119.9	96.7	84.1	99.8	78.1	83.4	79.9
	101.1	105.6	103.1	108.5	101.0	90.9	94.0	116.0	80.2	84.6	88.9	89.1	82.4	91.9
	102.1	107.7	107.7	107.7	105.5	150.7	113.2	114.9	86.5	94.4		103.1		91.9
	101.5	83.5	90.6	109.1	104.7	88.4	112.9	115.9	88.1	93.9				90.5
		100.3	95.1	97.2		92.1	92.8	116.5	94.2	97.6				98.1
		99.0	87.5	121.4			86.7	115.3	84.6	95.5				92.7
		100.5	89.5	110.5			92.9	115.1	86.7	84.0				81.9
		101.3	84.8	113.4			96.1	113.5	82.4	98.8				
		89.0	96.9	117.8			113.3	114.2	81.9	91.5				
			92.4	105.8			113.7	116.6(2)	90.7	99.6				
			98.5	119.1			100.8	118.0	87.8	92.6				
			91.6	100.3			104.0		90.3	93.8				
			98.1	109.6			91.7		90.7	87.8				
			91.3	113.2			109.8		82.4	88.9				
			96.4	102.9			106.2		85.9	96.6				
			103.6	105.4			91.6		79.0	96.6				
			111.3	114.7			100.8		81.3	42.8				
			93.1	101.6			100.3		84.9	106.1				
			115.9	118.9			96.6		86.0	96.0				
			100.0	114.7			86.1		84.2	94.3				
			86.1	109.6			96.6		79.8	86.7				
			105.8	105.1			88.5		86.0	83.2				
			79.8				94.9			96.6				
			99.0				92.3			90.9				
			99.9				83.8			—				
			78.8				82.8			91.2				
			75.9				81.4			95.0				
			97.1				99.9			97.0				
			89.1				110.7			98.4				
			89.0				109.2			95.9				
			97.1				111.5							
			80.5				109.0							
			103.5				111.2							
			90.0				111.1							
			108.5				104.6							
			87.8				110.6							
			89.2				103.3							
			104.0				96.9							
							90.8							
							104.7							
							94.0							
							92.8							
N	5	10	39	23	5	6	43	13	23	31	3	4	3	8
E	102.2	101.2	103.8	113.4	106.5	100.7	106.6	115.3	88.8	94.8	88.2	97.8	81.4	92.4
S	.97	1.8	5.5	32.3	1.8	1.4	6.6	13.0	.11	.25	.02	.96	.01	.20

N - Number of Measurements; E - Energy Avg., dB; S - Energy Standard Deviation, $X10^{-10}$

TABLE A-12 MEASURED SEL TABULATION FORM, SITE 2

AC - KC 135A				AC - B52G				AC - A-37		AC - T-37		AC - T-38	
Approach		T/O		Approach		T/O							
SI	Patt	Pat	SO	SI	Pat	Pat	SO	Approach	T/O	Approach	T/O	Approach	T/O
99.6	77.9	83.9	115.0	96.3	100.7	97.1	109.4	—	76.1	81.1	91.1	—	89.6
94.5	77.9	106.6	113.3	97.8	96.1	80.9	113.2	—	79.1	73.6	—	—	—
94.0	99.3	93.9	108.5	99.4	76.8	84.3	113.8	—	78.7	72.3	81.4	—	89.5
94.9	92.8	93.1	112.8	96.7	89.7	105.9	104.1	—	91.3	77.7	92.7	81.3	91.9
95.2	—	73.1	99.1	96.5	74.8	103.5	112.6	—	92.5	—	84.9	73.2	83.1
97.0	86.6	85.8	88.7	95.1	77.8	80.8	110.9	—	—	74.5	82.6	81.7	92.2
98.3	82.9	78.3	113.7	99.0	87.2	76.2	114.8	—	80.0	71.5	—	81.5	81.0
96.5	95.0	76.3	108.0	95.1	95.0	—	113.3	—	70.0	81.0	88.7	76.4	—
100.3	83.9	80.4	107.2	95.2	100.0	98.7	114.0	—	92.6	—	88.8	84.0	88.6
94.4	—	86.3	111.7	98.0	100.7	101.1	114.8	—	89.8	76.5	—	—	—
88.9	85.0	82.0	108.0	97.6	96.7	106.1	112.5	86.9	91.1	79.8	—	78.8	—
82.5	94.7	88.1	116.4	98.0	100.0	86.6	111.0	90.7	84.4	81.9	—	79.8	87.9
96.7	76.8	88.0	105.9	—	95.0	82.3	108.4	90.4	89.0	80.1	92.0	81.3	
72.6	88.5	86.7	108.8	98.8	92.2	76.6	113.3	76.3	79.7	80.1	96.7	69.5	
74.8	92.7	81.0	114.7	94.4	88.7	105.9	109.3	—	84.6	78.6	90.0	78.3	
95.3	94.2	88.8	96.6	84.9	100.2	91.9	113.7	74.0	90.2	—		—	
94.4	93.5	92.0	108.9	96.5	96.5	73.3	114.9	—	85.0	75.9		71.7	
89.0	—	101.3	112.0	94.0	96.2	88.2	100.8	—	85.2	78.4		79.3	
94.4	71.4	93.4	91.9	95.1	99.2	87.4	107.6	—	94.0	—		83.6	
96.9	75.5	113.2	100.4	95.2	99.0	85.7	115.0	80.6	91.4	76.4		86.5	
95.1	95.9	85.8	117.9	98.6	—	71.4	115.9	—	90.2	86.1		82.1	
73.2	94.6	75.5	104.5		98.8	85.8	111.8	78.3	—	77.9		81.0	
82.5	88.5	91.1	108.2		94.4	76.0	114.6	73.3	81.8	—		81.1	
94.4	84.1	—	105.9		84.8	83.8	110.4	68.6	93.1	74.7		80.0	
88.9	95.3	86.1	114.4		96.5	81.5	114.8	77.5	91.0	70.4		74.7	
89.5	87.1	88.9	109.7		97.8	65.5	114.8	82.9	—	78.0		—	
72.6	88.8	73.9	116.3		97.1	69.9	110.4	80.0	80.8	73.9		78.2	
74.8	93.1	—	105.8		94.0	-		79.1	87.6	—		79.8	
94.4	88.2	88.1	106.6		96.8	66.0		77.9	97.1	73.1		97.6	
96.9	82.4	—	114.0		96.6	104.6		84.0	97.4	81.2		77.3	
95.6	108.1	78.0	109.0		95.2	111.5		78.6	94.0	72.8		85.4	
89.2	98.4	—	108.8		94.8	105.5		87.9	94.5	73.4		84.8	
94.8	99.9	—	104.9		91.2	106.9		78.9	87.1	76.2		95.0	
88.4	100.7	94.2	108.8		95.5	100.3		78.8	87.4	73.9		85.4	
95.0	97.0	81.7	104.9		95.8	101.0		80.9	98.0	71.2		99.4	
93.9	95.7	96.3			86.9	96.8		83.6	86.0	76.5		82.6	
94.9	76.0	77.9			96.0	106.2		85.9	94.9			92.1	
96.9	98.0	72.6			97.9	93.5		81.4	87.8			—	
95.1	84.4	90.8			98.4	87.2		78.4	95.5			86.0	
73.2	94.6	85.3			95.1	77.9		—	90.8			74.8	
82.5	95.8	85.9			97.2	96.0		83.8	75.6			86.8	
	95.4	101.3			95.0	83.4		82.0	86.1				
	79.0	97.9			100.0	83.0		66.6	91.5				
	96.9	87.0			100.7	85.9		78.6	72.8				
	93.6	86.8			96.7	88.4		75.6	71.3				
	88.2	99.6			100.0	104.2		85.2	90.0				
	94.8	92.6			95.0	87.1		70.2	86.8				
	95.0	92.9			93.2	70.7		88.8	75.0				
	79.8				88.7	72.3		80.2	—				
	99.0				100.2	103.8		81.0	80.8				

N - Number of Measurements; E - Energy Avg., dB; S - Energy Standard Deviation, X10^{-10}

TABLE A-12 MEASURED SEL TABULATION FORM, SITE 2 (continued)

	AC - KC 135A				AC - B52G				AC - A-37		AC - T-37		AC - T-38	
	Approach		T/O		Approach		T/O		Approach	T/O	Approach	T/O	Approach	T/O
	SI	Patt	Pat	SO	SI	Pat	Pat	SO						
		99.6				96.5	103.8		86.9	71.5				
		87.0				96.2	87.4		82.5	—				
		—				99.2	97.0		75.0	101.5				
		94.1				.0	—		87.5	—				
		86.4				97.8	92.1		72.8	92.7				
		94.7				97.1	88.2		87.8	95.9				
		95.2				94.0	89.6		81.5	92.5				
		92.1				96.8	87.6		—	92.0				
		87.4				96.6	74.0		—	82.8				
		93.6				95.2	96.3		—	89.0				
		95.7				94.8	106.7		—					
		96.6				91.2	88.8		90.2					
		94.9				95.8	85.4		98.6					
		75.5				95.5	104.9		78.9					
		95.8				86.9	82.7		77.5					
		94.6				96.0	84.2							
		88.5				97.4	83.1							
		84.1				98.4	86.5							
		87.0				98.0	89.3							
		96.7					[illegible]							
		95.3					98.9							
		87.1					85.7							
		88.8					76.0							
		93.1					91.6							
		88.2					85.4							
		82.4					95.9							
		108.1					84.8							
		98.4					70.5							
		99.8					91.4							
		100.7					95.5(3)							
		96.0												
		95.7												
		76.0												
		88.0												
		94.4												
		94.6												
		93.8												
		95.4												
		79.0												
		79.8												
		99.0												
		99.6												
		87.0												
		—												
		94.1												
		86.4												
		94.7												
		95.2												
		92.1												
		97.4												
N	40	100	48	~~55~~	21	69	81	28	66	60	36	15	41	12
E	94.1	95.9	98.3	111.2	96.1	96.1	100.1	112.4	84.0	91.3	77.5	89.2	87.7	87.5
S	.23	.91	3.1	14.5	.23	.30	2.77	17.0	.09	.22	.007	.12	.16	.06

N - Number of Measurements; E - Energy Avg., dB; S - Energy Standard Deviation, $X10^{-10}$

TABLE A-12 MEASURED SEL TABULATION FORM, SITE 3

	AC - KC 135A				AC - B52G				AC - A-37		AC - T-37		AC - T-38	
	Approach		T/O		Approach		T/O		Approach	T/O	Approach	T/O	Approach	T/O
	SI	Patt	Pat	SO	SI	Pat	Pat	SO						
		—	77.3	106.7	86.3	—	89.0	107.1	—	70 72	—	80.3	—	83.5
		—	97.3	103.1	88.1	—	77.1	104.1	—	—	—	—	—	—
	70.9	89.5	87.9	102.1	86.5	—	82.0	102.3	—	—	—	72.6	—	87.1
	82.7	82.8	87.0	106.0	85.0	—	96.8	86.9	—	86.8	—	87.0		95.7
	85.5	—	75.8	91.3	—	—	93.0	103.8	—	91.0	—			75.5
	87.4	79.6	74.9	85.5		—	—	101.3	—	84.0	—			82.6
	86.9	—	74.0	103.8			—	107.7	—	71.9				—
	87.8	87.0	—	98.1			—	107.4	—	—				—
	92.2	82.0	94.1	98.5			94.5	110.1	—	86.5				
		—	94.1	104.2			91.0	109.3	—	83.9				
		86.4	81.9	103.1			86.6	113.8(2)	76.5	86.3				
		86.4	85.3	106.5			86.2	103.1	82.7	79.5				
		—	81.8	111.9			87.3		81.1	83.9				
		—	81.6	109.5			76.8		—	—				
			75.5	102.8			97.5		—	—				
			83.2	90.1			84.9		—	—				
			85.0	105.8			71.4		—	94.1				
			83.9	103.7			78.9		—	79.8				
			87.0	86.9			83.6		—	89.7				
			99.0	92.6			76.6		—	87.7				
			77.2	106.8			—		—	84.8				
			—	94.3			81.7		—	—				
			85.1	106.6			65.1		—	72.8				
			64.4				91.9		—	86.3				
			82.6				79.4		—	80.2				
			83.7				—		—	79.8				
			82.7(2)				—		—	—				
			—				70.8			83.4				
			92.8				65.0			90.5				
			78.6				84.2			93.4				
			69.8				98.6			85.3				
			80.3				88.1							
			—				93.4							
			87.6				94.6							
			70.8				80.9							
			94.1				97.9							
			—				90.0							
			73.0				84.0							
			84.2				—							
							95.8							
							73.2							
							78.0							
N	7	14	40	23	4	-	42	13	27	31	—	4	—	8
E	886	829	878	104.6	86.6	-	90.4	107.1	71.3	86.0	—	82.0	—	82.2
S	.05	.02	.15	3.5	.01	-	.19	4.25	.004	.06	—	.02	—	.02

N - Number of Measurements; E - Energy Avg., dB; S - Energy Standard Deviation, $X10^{-10}$

TABLE A-12 MEASURED SEL TABULATION FORM, SITE 202

AC - KC 135A				AC - B52G				AC - A-37		AC - T-37		AC - T-38	
Approach		T/O		Approach		T/O		Approach	T/O	Approach	T/O	Approach	T/O
SI	Patt	Pat	SO	SI	Pat	Pat	SO						
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	—	.	80.6	.
.	.	.	.	.	.	.	.	.	.	74.2	—	73.4	.
93.9	.	.	.	97.3	.	.	.	.	.	—	84.0	78.9	.
93.5	.	.	.	87.1	96.0	.	.	.	.	—	74.0	75.5	
94.0	.	.	.	96.2	99.2	.	.	.	.	75.0	86.5	79.4	.
83	.	.	.	—	97.6	.	.	.	.	—	87.5	83.9	88.[illegible]
98.1	.	.	.	—	96.6	.	.	.	.	70.8	84.8	77.1	—
—	93.8	.	.	—	100.6	.	.	.	.	81.3	87.2	.	72.0
—	94.3	.	.	—	78.7	.	.	.	.	83.3	83.7	.	84.3
91.0	—	.	.	94.7	95.1	.	.	.	.	78.2	89.8	.	
—	—	.	.	104.1	95.1	.	107.8	.	.	80.7	85.8	.	
—	82.2	.	.	91.5	92.7	.	116.1	.	.	.	71.5	.	
101.5	91.4	.	.	71.4	94.3	.	108.6	.	.	.		.	
95.8	72.0	.	.	101.5	94.5	.	113.1	.	.	.		.	
—	74.1	.	.	87.1	100.1	.	116.5	.	.	.		.	
—	—	.	.	96.2	102.9	.	86.6	.	.	.		.	
—	71.7	.	.	.	95.4	.	102.9	.	.	.		.	
—	—	.	.	.	94.7	.	100.3	.	.	.		.	
—	—	.	.		104.1	.	111.3	.	.	.		.	
—	—	.	.		91.5	.	108.3	.	.	.		.	
98.1	—	.	97.1		71.4	.	114.3	—	.	.		.	
—	100.2	.	107.4		101.5	.	108.3	—	.	.		.	
—	96.4	.	108.1		95.7	.	108.3	80.6	.	.		.	
—	87.7	.	109.7		101.7	.	114.3	81.2	.	.		.	
—	93.3	.	98.9		—	.	108.1	—	.	.		.	
95.8	88.6	.	91.2		98.1	.		69.6	.	.		.	
.	94.0	.	109.1		95.9	.		—	.	.		.	
.	101.0	.	109.0		—	.		73.5	.	.		.	
.	96.2	.	108.9		97.9	.		81.3	89.1	.		.	
.	102.2	.	101.2		72.8	.		74.2	71.2	.		.	
.	94.7	.	108.9		—	.		78.4	—	.		.	
.	93.0	.	101.2		—	.		83.4	87.6	.		.	
.	85.1	.			84.8	.		70.8	81.5	.		.	
.	75.4	.			95.3	.		86.5	93.0			.	
.	90.3	.			—	.		—	87.7			.	
.	96.3	.			97.1	.		78.2	90.7			.	
.	96.0	.			97.3	.		80.3	80.0			.	
.	93.2	—			96.0	.		74.4	74.1			.	
	—	89.2			94.2	.		.	84.7				
	79.1	73.8			97.6	.		.	—				
	—	—			96.6	75.8		.	—				
	—	—			100.6	—		.	87.0				
	—	—			78.7	86.1		.	84.9				
	—	—			95.1	—		.	—				
	—	—			85.1	—		.	—				
	—	—			92.7	—		.	77.9				
	—				94.3	84.8		.	—				

N - Number of Measurements; E - Energy Avg., dB; S - Energy Standard Deviation, X10^{-10}

TABLE A-12 MEASURED SEL TABULATION FORM, SITE 202 (continued)

	AC - KC 135A				AC - B52G				AC - A-37		AC - T-37		AC - T-38	
	Approach		T/O		Approach		T/O							
	SI	Patt	Pat	SO	SI	Pat	Pat	SO	Approach	T/O	Approach	T/O	Approach	T/O
		91.0				94.5	85.9			—				
		—				100.1	—			—				
		85.7				102.9	—			—				
		[illegible]				95.4	91.8			89.8				
		—				95.7	—			86.2				
		—				101.7	—			86.6				
		—				—	—			88.4				
		—				98.1	80.7			87.3				
		—				95.9	—			74.3				
		—					—			87.9				
		—					105.1							
		—					—							
		—					—							
		[illegible]					99.0							
							69.8							
		—					—							
		—					—							
		—					—							
		—					—							
		[illegible]					100.6(?)							
		[illegible]					—							
		96.4					—							
		83.7					—							
		[illegible]					—							
		[illegible]					—							
		[illegible]					86.2							
		[illegible]					—							
		96.2					—							
		102.2					—							
		74.7					—							
		[illegible]												
		[illegible]												
		[illegible]												
		90.3												
		[illegible]												
		96.0												
		93.2												
		—												
		79.1												
N	24	79	9	12	14	53	38	15	18	29	11	11	7	4
E	97.8	92.7	79.8	106.8	96.2	97.2	92.8	111.5	78.9	85.5	77.4	85.3	79.6	83.8
S	.33	.36	.02	3.6	.73	.56	.61	14.0	.01	.05	.01	.03	.01	.03

N - Number of Measurements; E - Energy Avg., dB; S - Energy Standard Deviation, $X10^{-10}$

AD-A088 033 BOLT BERANEK AND NEWMAN INC CANOGA PARK CALIF F/G 14/2
DEVELOPMENT OF NOISECHECK TECHNOLOGY FOR MEASURING AIRCRAFT NOI--ETC(U)
MAY 80 P E RENTZ, H SEIDMAN F33615-77-C-0514

UNCLASSIFIED BBN-3862 AMRL-TR-78-125 NL

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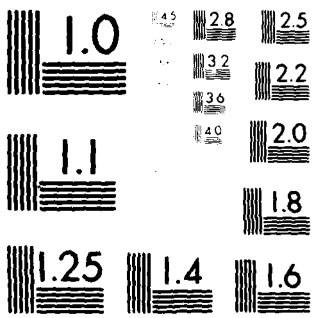

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

TABLE A-12 MEASURED SEL TABULATION FORM, SITE 203

AC - KC 135A				AC - B52G				AC - A-37		AC - T-37		AC - T-38	
Approach		T/O		Approach		T/O		Approach	T/O	Approach	T/O	Approach	T/O
SI	Patt	Pat	SO	SI	Pat	Pat	SO						
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	82.5	.
.	.	.	.	.	.	.	.	.	.	.	—	81.3	.
.	.	.	.	105.2	.	.	.	.	.	.	83.9	87.3	.
.	.	.	.	86.2	98.5	.	.	.	.	83.0	—	85.6	.
.	.	.	.	97.3	107.1	.	.	.	.	84.7	81.9	77.8	.
.	.	.	.	105.0	102.5	.	.	.	.	70.7	—	82.4	90.5
101.1	.	.	.	104.9	107.7	.	.	.	.		—	89.9	74.3
—	.	.	.	103.4	70.8	.	.	.	.	83.4	—	—	—
—	.	.	.	104.9	105.7	.	—	.	.	80.9	—	87.1	78.1
100.5	.	.	.	106.9	104.6	.	107.2	.	.	—	—	71.3	
83.9	.	.	.	102.7	106.6	.	97.8	.	.	82.8	71.3	74.5	
90.1	99.6	.	.	101.8	106.0	.	110.1	.	.	—	73.2	84.8	
101.9	93.4	.	.	86.9	96.7	.	105.3	.	.	—		81.6	
98.2	98.6	.	.	84.5	104.5	.	102.9	.	.	88.1		81.1	
93.4	—	.	.	86.2	101.6	.	—	.	.	72.5		—	
99.0	—	.	.	99.3	101.9	.	101.4	.	.	101.3		86.2	
99.4	—	.	.	109.0	103.2	.	81.0	.	.	—		—	
85.5	—	.	.	102.4	106.7	.	98.3	.	.	—		81.0	
—	—	.	.		102.7	.	108.1	.	.	—		74.6	
—	85.5	.	85.2		101.8	.	98.5	.	.	72.2		82.1	
101.1	—	.	106.0		86.9	.	109.0	.	.	—		—	
—	99.6	.	88.9		84.5	.	109.1	.	.	—		—	
—	88.4	.	94.2		100.2	.	98.5	.	.	—		85.2	
83.9	97.7	.	92.6		99.5	.	109.0	.	.	—		—	
90.1	96.4	.	101.7		—	.		—	.	90.5		85.8	
98.2	91.4	.	105.7		100.2	.		65.8	.	—		—	
—	84.0	.	102.0		100.7	.		—	.	—		—	
109.9	103.5	.	96.0		99.5	.		82.8	.	—		—	
94.6	98.6	.	96.7		107.3	.		90.8	73.2	—		—	
92.2	101.4	.	95.9		105.0	.		78.0	—	81.5		—	
93.4	99.5	.	96.7		100.6	.		79.9	—	78.9		72.70	
99.3	102.2	.			100.7	.		81.7	70.7	—		108.4	
95.2	105.7	.			—	.		84.4	—	75.5		82.5	
99.0	82.4	.			100.9	.		80.8	76.4			—	
99.4	—	.			96.0	.		78.5	72.4			82.3	
85.5	95.6	.			98.5	.		87.0	68.6			80.9	
—	102.1	.			105.2	.		81.2	—			—	
—	94.2	—			98.5	.		79.9	—				
	—	—			107.1	.		95.2	—				
	81.1	—			102.5	.		87.0	—				
	—	—			107.7	—		88.6	—				
	109.9	—			70.8	—		—	—				
	94.6	—			105.7	—		—	85.6				
	92.2	—			104.6	—		—	—				
	99.9	—			106.6	—		—	—				
	—	.			106.0	—		—	—				
	96.1	.			98.6	—		—	—				

N - Number of Measurements; E - Energy Avg., dB; S - Energy Standard Deviation, $X10^{-10}$

TABLE A-12 MEASURED SEL TABULATION FORM, SITE 203(continued)

	AC - KC 135A				AC - B52G				AC - A-37		AC - T-37		AC - T-38	
	Approach		T/O		Approach		T/O		Approach	T/O	Approach	T/O	Approach	T/O
	SI	Patt	Pat	SO	SI	Pat	Pat	SO						
		93.8				101.5	—		—	69.7				
		73.0				101.6	—		86.3	75.3				
		—				101.9	—		—	67.1				
		98.2				103.2	101.2		—	—				
		97.6				100.2	—		79.8	76.5				
		98.0				99.5	—		—	—				
		98.0				—	—		88.4	75.2				
		95.3				99.2	87.0		90.2	84.4				
		90.4				100.7	—		71.4	—				
		92.7				99.5	—		72.9	68.7				
		98.3				107.3	106.2		84.0					
		99.4				105.0	—		81.4					
		95.6				100.6	—		93.9					
		—				100.7	87.3		109.6					
		—				—	—		—					
		—				100.9	—		78.1					
		85.5				95.9	—							
		—				98.5	—							
		89.4				109.9	—							
		100.5					(101.5(2))							
		99.6					—							
		88.4					—							
		97.7					—							
		96.4					—							
		91.4					—							
		84.0					78.6							
		103.5					—							
		98.6					—							
		101.4					—							
		89.5					—							
		102.2												
		105.7												
		82.4												
		—												
		85.6												
		102.1												
		94.2												
		—												
		81.1												
		—												
		96.1												
		93.8												
		73.0												
		—												
		98.2												
		97.6												
		98.0												
		88.0												
		95.3												
		90.4												
N	32	86	—	12	16	63	38	16	39	29	30	11	37	4
E	98.3	97.7	—	100.4	102.7	102.9	93.5	104.7	94.2	74.7	87.4	76.0	93.0	77.1
S	1.72	1.24	—	1.38	1.90	1.70	.75	3.26	1.46	.01	.25	.01	1.14	-

N - Number of Measurements; E - Energy Avg., dB; S - Energy Standard Deviation, $X10^{-10}$

exceed the SEL threshold at the particular site. Dots represent events which occurred when the portable noise level monitor was not operational at that site at the time.

Sample energy averages and standard deviations were computed from the tabulated data using Eqs. (8) and (9).

$$\overline{L_{AE}} = 10 \log \frac{1}{n} \sum_{q} 10^{\frac{L_{AE}}{10}} \tag{8}$$

$$s^2 = \frac{1}{n - 1} \left[\sum_{q} \left(10^{\frac{L_{AE}}{10}} \right)^2 - n \left(10^{\frac{\overline{L_{AE}}}{10}} \right)^2 \right] \tag{9}$$

where

L_{AE} = individual A-weighted sound exposure level (SEL), dB

$\overline{L_{AE}}$ = energy average A-weighted sound exposure level (SEL), dB

s = sample standard deviation for SEL values as an antilog with 1.0 equal to the sound level reference of 20μ N/m^2

n = number of SEL values in the sample

q = summation index for SEL values for a specific aircraft/operation

Zero was used as the SEL level for events which did not register at a site (dashes in Table A-12).

SYNTHESIS OF AVERAGE DAY DNL VALUES

The individual aircraft average SEL values were used to synthesize average day DNL estimates as shown in Table A-13. In this table the measured SEL values are expressed in decibels. The equivalent day acoustic energy was derived by multiplying the individual energy average SEL antilog values by the

Table A-13 Summation of Mean and Variance of Measured SEL Contribution to Synthesized DNL Values

Site 1

Type A/C	Operations App SI	App Patt	T/O Patt	T/O SO	Aver. Day Frequency Day, F_D	Night F_N	Equiv. Day $F=F_D+10F_N$	Average Measured SEL	Equivalent Day DNL Value
KC -	✓				3.180	0.510	8.28	102.2	62.0
135A		✓			12.412	2.670	39.112	101.2	67.7
			✓		8.240	1.780	26.04	103.8	68.6
				✓	2.871	0.426	7.131	113.4	72.5
B52G	✓				2.910	0.960	12.51	106.5	68.1
		✓			9.750	3.600	45.75	100.7	67.9
			✓		6.480	2.400	30.48	106.6	72.0
				✓	2.436	0.225	4.686	115.3	72.6
A-37	✓				14.430	0.092	15.35	88.8	51.3
		✓			7.168	0.144	8.608	88.8	48.7
			✓		4.770	0.099	5.76	94.8	53.0
				✓	5.420	0.140	6.820	94.8	53.7
T-37	✓				5.400	0	5.40	88.2	46.1
		✓			19.260	0	19.26	88.2	51.6
			✓		10.50	0.02	10.70	97.8	58.7
				✓	3.580	0.02	3.78	97.8	54.2
T-38	✓				1.780	0.102	2.80	81.4	36.5
		✓			4.160	0.298	7.14	81.4	40.5
			✓		2.548	0.172	4.268	92.4	49.3
				✓	1.190	0.07	1.890	92.4	45.8
T-39	✓				2.540	1.220	14.74	92.3	54.6
		✓			5.230	0.190	7.13	92.3	51.4
			✓		3.490	0.820	11.69	92.3	53.6
				✓	2.370	0.130	3.67	92.3	48.5
Other	✓				2.80	0.10	3.80	-	-
		✓			5.875	0.57	11.575	-	-
			✓		4.08	0.41	8.18	-	-
				✓	1.75	0.07	2.45	-	-
Totals					156.62	17.238	329		
Energy Average DNL, $\overline{L_{dn}}$, dB									79.1
NOISEMAP DNL Prediction, dB (REF)									80.5

Table A-13 Summation of Mean and Variance of Measured SEL Contribution to Synthesized DNL Values

Site 2

Type A/C	Operations App SI	App Patt	T/O Patt	T/O SO	Aver. Day Frequency Day, F_D	Night F_N	Equiv. Day $F=F_D+10F_N$	Average Measured SEL	Equivalent Day DNL Value
KC - 135A	✓				3.180	0.510	8.28	94.1	53.9
		✓			12.412	2.670	39.112	95.9	62.4
			✓		8.240	1.780	26.04	98.3	63.1
				✓	2.871	0.426	7.131	111.2	70.3
B52G	✓				2.910	0.960	12.51	96.1	57.7
		✓			9.750	3.600	45.75	96.1	63.3
			✓		6.480	2.400	30.48	100.1	65.5
				✓	2.436	0.225	4.686	113.4	70.7
A-37	✓				14.430	0.092	15.35	84.0	46.5
		✓			7.168	0.144	8.608	84.0	43.9
			✓		4.770	0.099	5.76	91.3	49.5
				✓	5.420	0.140	6.820	91.3	50.2
T-37	✓				5.400	0	5.40	77.5	35.4
		✓			19.260	0	19.26	77.5	40.9
			✓		10.50	0.02	10.70	89.2	50.1
				✓	3.580	0.02	3.78	89.2	45.6
T-38	✓				1.780	0.102	2.80	87.7	42.8
		✓			4.160	0.298	7.14	87.7	46.8
			✓		2.548	0.172	4.268	87.5	44.4
				✓	1.190	0.07	1.890	87.5	40.9
T-39	✓				2.540	1.220	14.74	88.1	50.4
		✓			5.230	0.190	7.13	88.1	47.2
			✓		3.490	0.820	11.69	93.9	55.2
				✓	2.370	0.130	3.67	93.9	50.1
Other	✓				2.80	0.10	3.80	-	-
		✓			5.875	0.57	11.575	-	-
			✓		4.08	0.41	8.18	-	-
				✓	1.75	0.07	2.45	-	-
Totals					156.62	17.238	329		
Energy Average DNL, $\overline{L_{dn}}$, dB									75.3
NOISEMAP DNL Prediction, dB (REF)									76.4

Table A-13 Summation of Mean and Variance of Measured SEL Contribution to Synthesized DNL Values

Site 3

Type A/C	App SI	App Patt	T/O Patt	T/O SO	Day, F_D	Night F_N	Equiv. Day $F=F_D+10F_N$	Average Measured SEL	Equivalent Day DNL Value
KC - 135A	✓				3.180	0.510	8.28	88.6	48.4
		✓			12.412	2.670	39.112	82.9	49.4
			✓		8.240	1.780	26.04	87.6	52.4
				✓	2.871	0.426	7.131	104.6	63.7
B52G	✓				2.910	0.960	12.51	86.6	48.2
		✓			9.750	3.600	45.75	0	0
			✓		6.480	2.400	30.48	90.4	55.8
				✓	2.436	0.225	4.686	107.1	64.8
A-37	✓				14.430	0.092	15.35	71.3	33.8
		✓			7.168	0.144	8.608	71.3	30.2
			✓		4.770	0.099	5.76	86.0	44.2
				✓	5.420	0.140	6.820	86.0	44.9
T-37	✓				5.400	0	5.40	0	0
		✓			19.260	0	19.26	0	0
			✓		10.50	0.02	10.70	82.0	42.9
				✓	3.580	0.02	3.78	82.0	38.4
T-38	✓				1.780	0.102	2.80	0	0
		✓			4.160	0.298	7.14	0	0
			✓		2.548	0.172	4.268	82.2	39.1
				✓	1.190	0.07	1.890	82.2	35.6
T-39	✓				2.540	1.220	14.74	0	0
		✓			5.230	0.190	7.13	0	0
			✓		3.490	0.820	11.69	87.3	48.3
				✓	2.370	0.130	3.67	87.3	43.5
Other	✓				2.80	0.10	3.80	-	-
		✓			5.875	0.57	11.575	-	-
			✓		4.08	0.41	8.18	-	-
				✓	1.75	0.07	2.45	-	-
Totals					156.62	17.238	329		
Energy Average DNL, $\overline{L_{dn}}$, dB									68.0
NOISEMAP DNL Prediction, dB (REF)									69.4

Table A-13 Summation of Mean and Variance of Measured SEL Contribution to Synthesized DNL Values

Site 202

Type A/C	Operations App SI	Operations App Patt	Operations T/O Patt	Operations T/O SO	Aver. Day Frequency Day, F_D	Aver. Day Frequency Night F_N	Aver. Day Frequency Equiv. Day $F=F_D+10F_N$	Average Measured SEL	Equivalent Day DNL Value
KC - 135A	✓				3.180	0.510	8.28	93.0	52.8
		✓			12.412	2.670	39.112	92.7	59.2
			✓		8.240	1.780	26.04	79.8	44.6
				✓	2.871	0.426	7.131	106.8	65.9
B52G	✓				2.910	0.960	12.51	96.2	57.8
		✓			9.750	3.600	45.75	97.2	64.4
			✓		6.480	2.400	30.48	92.8	58.1
				✓	2.436	0.225	4.686	111.5	68.8
A-37	✓				14.430	0.092	15.35	78.9	41.4
		✓			7.168	0.144	8.608	78.9	38.8
			✓		4.770	0.099	5.76	85.5	43.7
				✓	5.420	0.140	6.820	85.5	44.4
T-37	✓				5.400	0	5.40	77.4	35.3
		✓			19.260	0	19.26	77.4	40.8
			✓		10.50	0.02	10.70	85.3	46.2
				✓	3.580	0.02	3.78	85.3	41.7
T-38	✓				1.780	0.102	2.80	79.6	34.7
		✓			4.160	0.298	7.14	79.6	38.7
			✓		2.548	0.172	4.268	83.8	40.7
				✓	1.190	0.07	1.890	83.8	37.2
T-39	✓				2.540	1.220	14.74	87.0	49.3
		✓			5.230	0.190	7.13	87.0	46.1
			✓		3.490	0.820	11.69	87.8	49.1
				✓	2.370	0.130	3.67	87.8	44.0
Other	✓				2.80	0.10	3.80	-	-
		✓			5.875	0.57	11.575	-	-
			✓		4.08	0.41	8.18	-	-
				✓	1.75	0.07	2.45	-	-
Totals					156.62	17.238	329		
Energy Average DNL, $\overline{L_{dn}}$, dB									72.3
NOISEMAP DNL Prediction, dB (REF)									75.8

Table A-13 Summation of Mean and Variance of Measured SEL Contribution to Synthesized DNL Values

Site 203

Type A/C	Operations App SI	App Patt	T/O Patt	T/O SO	Aver. Day Frequency Day, F_D	Night F_N	Equiv. Day $F=F_D+10F_N$	Average Measured SEL	Equivalent Day DNL Value
KC - 135A	✓				3.180	0.510	8.28	98.5	58.3
		✓			12.412	2.670	39.112	97.7	64.2
			✓		8.240	1.780	26.04	0	0
				✓	2.871	0.426	7.131	100.4	59.5
B52G	✓				2.910	0.960	12.51	102.7	64.3
		✓			9.750	3.600	45.75	102.9	70.1
			✓		6.480	2.400	30.48	93.5	58.9
				✓	2.436	0.225	4.686	104.7	62.0
A-37	✓				14.430	0.092	15.35	94.2	56.7
		✓			7.168	0.144	8.608	94.2	54.1
			✓		4.770	0.099	5.76	74.7	32.9
				✓	5.420	0.140	6.820	74.7	33.6
T-37	✓				5.400	0	5.40	87.4	45.3
		✓			19.260	0	19.26	87.4	50.8
			✓		10.50	0.02	10.70	76.0	36.9
				✓	3.580	0.02	3.78	76.0	32.4
T-38	✓				1.780	0.102	2.80	93.0	48.1
		✓			4.160	0.298	7.14	93.0	52.1
			✓		2.548	0.172	4.268	77.1	34.0
				✓	1.190	0.07	1.890	77.1	30.5
T-39	✓				2.540	1.220	14.74	89.7	52.0
		✓			5.230	0.190	7.13	89.7	48.8
			✓		3.490	0.820	11.69	79.7	41.0
				✓	2.370	0.130	3.67	79.7	35.9
Other	✓				2.80	0.10	3.80	-	-
		✓			5.875	0.57	11.575	-	-
			✓		4.08	0.41	8.18	-	-
				✓	1.75	0.07	2.45	-	-
Totals					156.62	17.238	329		
Energy Average DNL, $\overline{L_{dn}}$, dB									73.2
NOISEMAP DNL Prediction, dB (REF)									73.7

NOISEMAP equivalent day frequency of occurrence F, summing, taking 10 times the logarithm of the sum and subtracting 49.4 dB for the number of seconds in a day. In equation form:

$$\overline{L_{dn}} = 10 \log(\sum_k \bar{E} \cdot F) - 49.4 \tag{10}$$

where

F = equivalent day average day aircraft frequency

$\bar{E}$ = energy average of SEL measurements for a specific aircraft/operation combination expressed as an antilog

k = summation index for different aircraft/operations.

Expressing the equivalent day DNL value for each type of aircraft operation in Table A-13 emphasizes the differences between the noise levels due to different aircraft. Summing the equivalent day energy values for the four smaller aircraft shows that they account for only 2.5 to 5 percent of the total energy. Excluding the four smaller aircraft decreases the DNL estimates by an average of only 0.2 dB, Table A-14.

Comparison of the SEL-based estimates from Table A-14 with the DNL-based estimates of Table A-10 shows that the SEL-based estimates are slightly higher. However, comparison with NOISEMAP values shows that SEL-based estimates are still consistently lower than predictions.

The use of SEL measurements to estimate average day DNL values has reduced the potential field test bias because the mix of operations during the field test is not a factor. In addition, the statistical uncertainty should be reduced because the number of data samples has been increased from the numbers of days to numbers of aircraft. Therefore, the most likely cause of the differences between measurements-based estimates and NOISEMAP predictions is incorrect NOISEMAP input data.

ANALYSIS BY EXTRAPOLATION FROM KEY SITE DNL ESTIMATE USING MEASURED HNL VALUES

COMPUTATION OF ENERGY AVERAGE HNL VALUES

To extrapolate from the key site (Site 2) to satellite sites (Sites 1, 3, 202, 203, and 4), energy average HNL values

TABLE A-14 AVERAGE DAY ESTIMATED DNL VALUES
BASED ON SEL MEASUREMENTS, dB

Site	All* Aircraft	Heavy** Aircraft	Difference All A/C(-) Heavy A/C	NOISEMAP (Ref)
1	79.1	79.0	.1	80.5
2	75.1	75.0	.1	76.4
3	68.2	68.1	0.1	69.4
202	72.4	72.4	0.1	75.8
203	73.3	73.0	0.3	73.7

* The six aircraft listed in Table A-13. These aircraft comprise 93% of Barksdale flight operations.

** B52G and KC135A

were computed for all sites from the HNL values listed in Table A-6. The averages were taken only for data measured simultaneously at the key site and the particular satellite site. Therefore, five different energy average HNL values were computed for Site 2 because no satellite site was operational for exactly the same time period as any other satellite site. The computation of energy average HNL was facilitated by using LEQ values for complete days, Eq. (12).

$$\overline{L_h} = 10 \log \frac{1}{24d + h} \left[24 \sum_{\ell} 10^{\frac{L_{24}}{10}} + \sum_{i} 10^{\frac{L_h}{10}} \right] \qquad (12)$$

where

$\overline{L_h}$ = energy average HNL value, dB

L_{24} = twenty-four hour average noise level (LEQ), dB

L_h = hourly noise level (HNL), dB

ℓ = summation index for complete measurement days at both key site and satellite site

i = summation index for hours from incomplete measurement days at both key site and satellite site

d = number of complete measurement days at both key site and satellite site

h = number of hourly noise level values from incomplete measurment days at both key site and satellite site.

In Table A-15 the energy average HNL values are presented, the site-to-site differences calculated, and the extrapolations from Site 2 to the satellite sites performed.

Extrapolations from two different Site 2 average day DNL estimates are presented, one based on DNL measurements and the other based on SEL measurements.

TABLE A-15 EXTRAPOLATION FROM KEY SITE TO SATELLITE SITE DNL VALUES USING ENERGY AVERAGE HNL VALUES

Satellite Site Number	Energy Average HNL, dB			DNL					Standard Deviation of HNL Differences		
				Key Site DNL From DNL's		Key Site DNL From SEL's					
	Satel Site	Key Site (2)	Δ HNL Satel (−) Key	Key* Site (2)	Satel Site	Key Site (2)	Satel Site	NOISE-MAP (Ref)	s, dB	n	$s/\sqrt{n}$ dB
1	74.6	71.6	3.0	72.7	75.7	75.3	78.3	80.5	5.1	11.5	0.5
3	65.3	71.7	-6.4	72.7	66.3	75.3	68.9	69.4	7.6	12.2	0.7
202	69.4	71.3	-1.9	72.7	70.8	75.3	73.4	75.8	6.0	9.1	0.6
203	67.8	69.4	-1.6	72.7	71.1	75.3	73.7	73.7	7.6	21.7	0.5
4	59.4	65.4	-6.0	72.7	66.7	75.3	69.3	69.0	8.9	14.6	0.7

* Corrected for number of operations.

POST TEST BIAS CORRECTIONS

Four types of post test overall corrections were considered. These were for atmospheric absorption bias, for temperature bias, for calibrator calibration bias, and for calibrator altitude correction.

An atmospheric absorption or humidity bias was evaluated by comparing the atmospheric absorption during the field test with average yearly atmospheric absorption. The atmospheric absorption values were determined by plotting temperature and relative humidity values on an absorption contour, Figure A-3. For the field test, temperature and relative humidity values taken every three hours were averaged separately, yielding 78.1° F and 73.5 percent relative humidity. Averaging the two parameters separately instead of plotting every point is valid because the points tend to lie on a straight line. This is evidenced by the monthly average data, also presented in Figure A-3. The atmospheric absorption difference between the field test and yearly average is 0.13 dB/1000 feet at 1000 Hz. An additional 0.1 dB/1000 feet at 1000 Hz exists between the Barksdale AFB yearly average and standard conditions (59° F, 70 percent relative humidity) which were used for the NOISEMAP computations.

The average temperature being greater than standard conditions also tends to decrease the noise levels because of decreased thrust and impedance changes. This is balanced somewhat by an increase in noise levels with decreased aircraft speed. Figure A-4 shows the combination of these temperature effects. For the Barksdale AFB field test, the estimated decrease in noise level due to increased temperature is 0.7 dB.

However, applying the corrections for these biases was considered unsound, especially for large slant distances (over 4000 feet) for two reasons:

- The higher than average temperature during the field test also affects the measured noise levels by lowering climb performance. Bias error corrections should include factors for this phenomena.
- For long slant distances, the peak in the frequency spectra tends to be shifted lower than 1000 Hz. Precise corrections should take the frequency spectra into consideration.

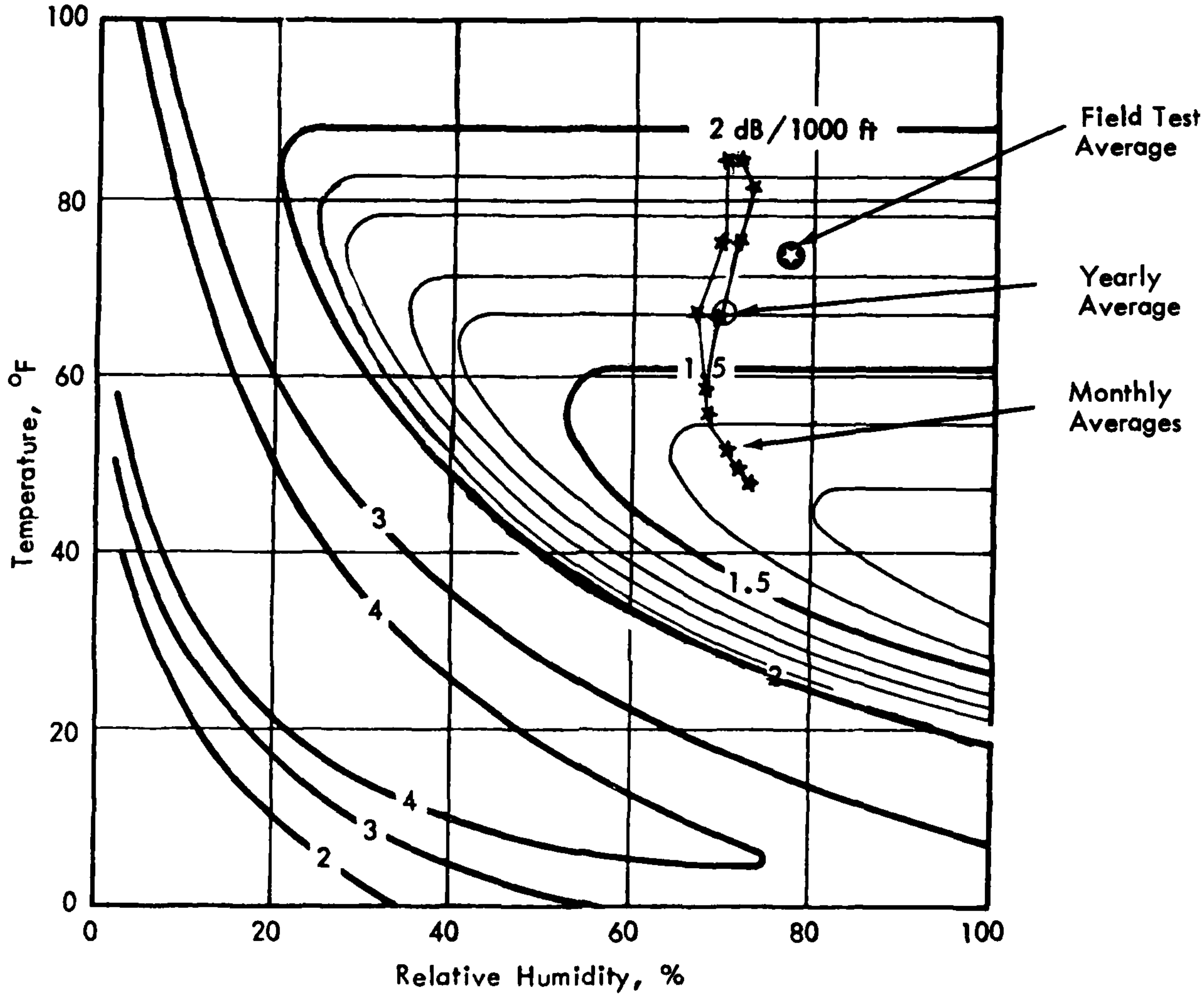

FIGURE A-3. 1000 Hz ABSORPTION VALUES (REF.16)

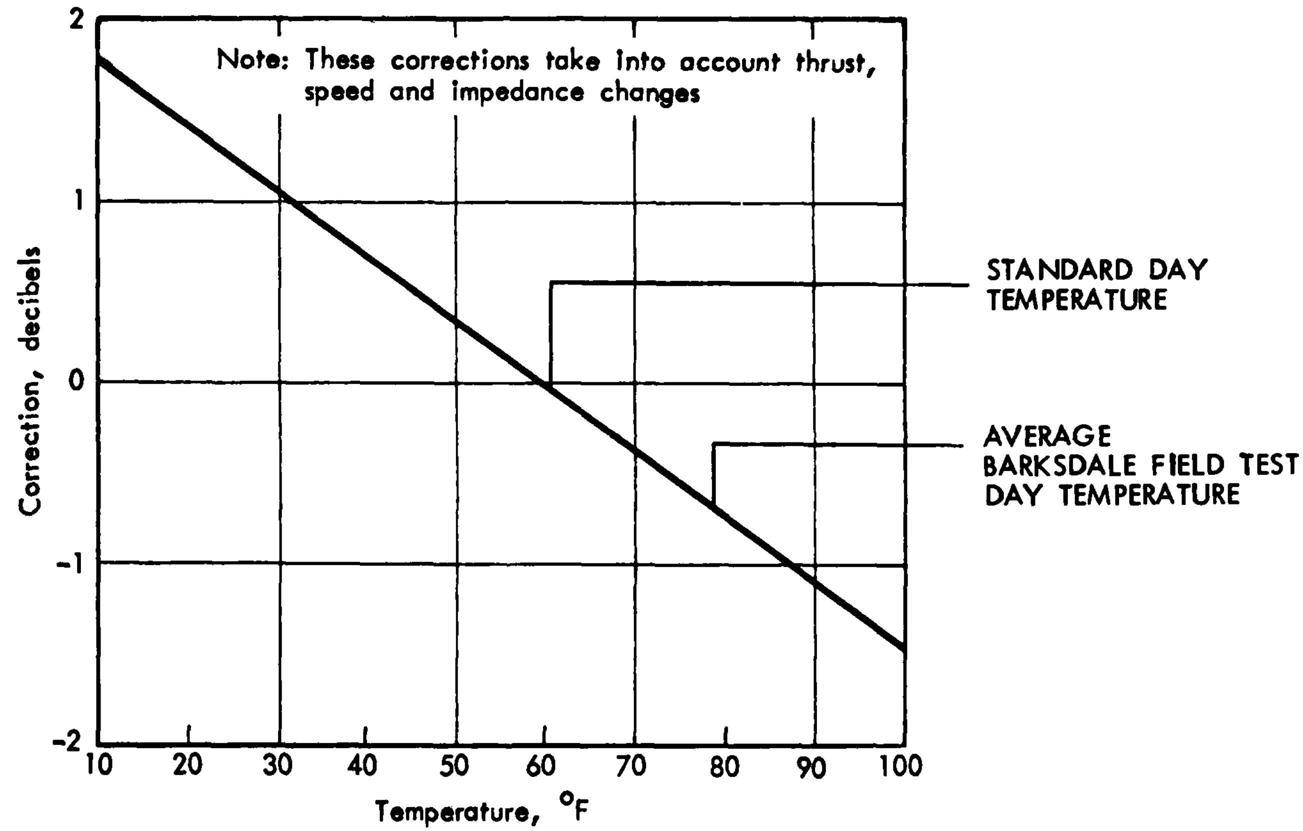

FIGURE A-4. CORRECTIONS FOR TEMPERATURE-THRUST VARIATIONS (REF. 17)

Instead of applying corrections, the atmospheric absorption bias, 0.1 to 0.2 dB, has been used as a measure of uncertainty in computing confidence intervals. The temperature-thrust bias has also been used as another contributor to the uncertainty.

Calibrator calibration bias, on the other hand, has been identified and corrections applied. Before the field test program, the calibrators were checked against a B&K model 4220 pistonphone using a variety of microphones as transfer transducers. The results showed the calibrators consistently producing 114.4 dB. After the field test, this was confirmed by factory calibration by GEN/RAD. As a result of this well documented bias, the experimental results were increased by 0.4 dB. This correction was applied to all reported levels throughout this document.

The acoustic output of calibrators decreases with atmospheric pressure at a rate of approximately 0.2 dB per 1000 feet altitude. However, the altitude at Barksdale AFB is only 164 feet above sea level. Since the resulting error is less than 0.05 dB, no corrections were applied to the measured levels.

CONFIDENCE LIMITS

Statistical confidence limits were derived from the measured data for all estimates of yearly average DNL. The 90 percent level confidence coefficient was employed. The selection of this confidence coefficient was essentially arbitrary, but it is consistent with current practice. In addition to the variabilities in the measured data, other uncertainties were evaluated. These include uncorrected temperature-humidity absorption bias, uncorrected temperature-thrust bias, instrumentation errors which weren't averaged during the field test, and unrepresentative flight activity during the field test. The ariances from all sources of error were combined to arrive at overall confidence intervals.

CONFIDENCE LIMITS FOR DNL-BASED ESTIMATES

Statistical confidence limits for the estimated yearly average DNL values were derived from the measured data. For estimates obtained from the measured DNL values, the Student t statistic with the number of degrees of freedom equal to one less than the sample size was utilized (see Table A-16).

The confidence limits were calculated from the DNL statistics of Table A-10 as follows.

$$\text{Confidence limits} = 10 \log \left[\text{Energy Avg.} \pm \frac{t}{\sqrt{n}} \text{ Energy Std Dev} \right] \quad (14)$$

For example, from Table A-10, for Site 2 with corrections for total aircraft volume,

$$\text{Confidence limits} = 10 \log \left[10^{\frac{72.7}{10}} \pm \frac{1.78}{\sqrt{13}} (1.44 \times 10^{7}) \right] \quad (15)$$
$$= \frac{74.1}{70.6} \text{ dB}$$

The confidence interval is the difference between the upper and lower limit, in this case 74.1 (-) 70.6 = 3.5 dB or 1.4,- 2.1 dB in relation to the average 72.7 dB.

The average day DNL estimates and the associated confidence intervals are summarized in Table A-17.

CONFIDENCE LIMITS FOR SEL-BASED ESTIMATES

Statistical confidence limits for the SEL-based estimates of yearly average DNL values were derived from the measured data. With the large number of SEL samples contributing to the computation, the normal distribution statistic for the 90th percentile, 1.64, was used. (Note that this is the limiting value for the Student t distribution as the sample size becomes large, Table A-16.) Confidence limits were calculated as follows:

$$\text{Confidence limits} = 10 \log \left[\sum_{k} (\bar{E}\ F) \pm 1.64 \sqrt{F\left(\frac{s}{\sqrt{n}}\right)^2} \right] - 49.4 \quad (16)$$

TABLE A-16 STUDENT t STATISTICAL DISTRIBUTION FACTORS FOR 90% CONFIDENCE IN ESTIMATION OF MEAN

Number of Samples	Statistical Degrees of Freedom	Student t factor for 90% Confidence	$t/\sqrt{n}$
2	1	6.31	4.46
3	2	2.92	1.69
4	3	2.35	1.18
5	4	2.13	0.95
6	5	2.02	0.82
7	6	1.94	0.73
8	7	1.90	0.67
9	8	1.86	0.62
10	9	1.83	0.58
11	10	1.81	0.55
12	11	1.80	0.52
13	12	1.78	0.49
14	13	1.77	0.47
15	14	1.76	0.45
16	15	1.75	0.44
17	16	1.75	0.42
18	17	1.74	0.41
19	18	1.73	0.40
20	19	1.73	0.39
21	20	1.73	0.38
22	21	1.72	0.37
23	22	1.72	0.36
24	23	1.71	0.35
25	24	1.71	0.34
26	25	1.71	0.34
27	26	1.71	0.33
28	27	1.70	0.32
29	28	1.70	0.32
30	29	1.70	0.31
31	30	1.70	0.31
∞	∞	1.64	0

Table A-17 Barksdale AFB Yearly DNL Estimates With Confidence Intervals Based Only on Sample Statistics

Data Source	SITE 1 Avg	1 90% CI	2 Avg	2 90% CI	3 Avg	3 90% CI	202 Avg	202 90% CI	203 Avg	203 90% CI	4 Avg	4 90% CI
All Days Measurements												
No Corrections	-	-	72.0	+2.5 -2.6	-	-	-	-	-	-	-	-
Corrected for total A/C	-	-	72.7	+1.4 -2.1	-	-	-	-	-	-	-	-
Corrected for heavy A/C	-	-	72.6	+1.4 -2.1	-	-	-	-	-	-	-	-
Week Days Measurements												
No Corrections	-	-	73.5	+1.3 -1.8	-	-	-	-	-	-	-	
Corrected for total A/C	-	-	73.2	+1.3 -1.9	-	-	-	-	-	-	-	
Corrected for heavy A/C	-	-	72.4	+1.6 -2.5	-	-	-	-	-	-	-	
SEL Synthesis Measured Data	79.1	+.2 -.2	75.3	+.3 -.2	68.0	+.4 -.4	72.3	+.4 -.1	73.2	+.1 -.1	-	-
Extrapolation from Site 2 DNL	75.7	±1.9	-	-	66.3	±2.1	70.8	±2.0	71.1	±1.9	66.7	±2.1
NOISEMAP (REF)	80.5		76.4		69.4	75.8		73.7		69.0		

where

F = equivalent day, average day aircraft frequency

E = energy average of SEL measurements for a specific aircraft/operation combination expresses as an antilog

s = standard deviation of energy of SEL measurements

k = summation index for different aircraft/operations

For example, from Table A-18 for Site 2

$$\text{Confidence limits} = 10 \log \left[296.49 \times 10^{10} \pm 1.64 \sqrt{99.85 \times 10^{20}} \right] - 49.4 \tag{17}$$

$$= 75.6/75.1$$

The confidence interval is +0.3, -0.2 in relation to the average value of 75.3 dB. The average day DNL estimates with associated confidence intervals are summarized in Table A-17.

CONFIDENCE LIMITS FOR EXTRAPOLATIONS FROM KEY SITE

Statistical confidence limits for the yearly average DNL estimates based on extrapolations from the key site were determined by combining the key site variability and the variability of HNL differences

$$\text{Confidence limits} = \overline{L_{dn}} + \Delta \pm 1.64 \sqrt{\left(\frac{CI}{2(1.64)}\right)^2 + s_\Delta^2} \tag{18}$$

where

$\overline{L_{dn}}$ = key site yearly average DNL estimate, dB

Δ = average energy HNL difference, satellite site (-) key site, dB

CI = confidence interval for the key site DNL estimate, dB

S_Δ = standard deviation of the arithmetic differences in HNL values, satellite site (-) key site.

TABLE A-18 SUMMATION OF MEAN AND VARIANCE OF MEASURED SEL CONTRIBUTION TO SYNTHESIZED DNL VALUES.

Site 2

Type A/C	Operations App SI	Operations App Patt	Operations T/O Patt	Operations T/O SO	Frequency Day, F_d	Frequency Night F_n	Frequency Equiv Day, F*	Measured SEL Energy Avg, dB	Measured SEL Energy Mean $\bar{E}$, $x10^{-10}$	Measured SEL Energy Std Dev, S $x10^{-10}$	Measured SEL No. SEL Samp. N	Measured SEL $\frac{S}{\sqrt{N}}$ $x10^{-10}$	Equiv. Day Energy $\bar{E}\cdot F$ $x10^{-10}$	Equiv. Day Varience, $F[s/\sqrt{N}]^2$ $x10^{-20}$
KC -	✓				3.180	0.510	8.28	94.1	.26	.23	40	.04	2.15	.01
135A		✓			12.412	2.670	39.112	95.9	.39	.91	100	.09	15.25	.32
			✓		8.240	1.780	26.04	98.3	.68	3.10	48	.45	17.71	5.27
				✓	2.871	0.426	7.131	111.2	13.18	14.5	35	2.45	93.99	42.80
B52G	✓				2.910	0.960	12.51	96.1	.41	.23	21	.05	5.13	.03
		✓			9.750	3.600	45.75	96.1	.41	.30	69	.04	18.76	.07
			✓		6.480	2.400	30.48	100.1	1.02	2.77	81	.31	31.09	2.93
				✓	2.436	0.225	4.686	113.4	21.88	17.0	28	3.21	102.53	48.29
A-37	✓				14.430	0.092	15.35	84.0	.03	.09	66	.01	.46	.00
		✓			7.168	0.144	8.608	84.0	.03	.09	66	.01	.26	.00
			✓		4.770	0.099	5.76	91.3	.13	.22	60	.03	.75	.01
				✓	5.420	0.140	6.820	91.3	.13	.22	60	.07	.89	.03
T-37	✓				5.400	0	5.40	77.5	.01	.007	36	-	.05	.00
		✓			19.260	0	19.26	77.5	.01	.007	36	-	.19	.00
			✓		10.50	0.02	10.70	89.2	.08	.12	15	.03	.86	.01
				✓	3.580	0.02	3.78	89.2	.08	.12	15	.03	.30	.00
T-38	✓				1.780	0.102	2.80	87.7	.06	.16	41	.02	.17	.00
		✓			4.160	0.298	7.14	87.7	.06	.16	41	.02	.43	.00
			✓		2.548	0.172	4.268	87.5	.06	.06	12	.02	.26	.00
				✓	1.190	0.07	1.890	87.5	.06	.06	12	.02	.11	.00
T-39	✓				2.540	1.220	14.74	88.1	.06	.14	20	.03	.88	.01
		✓			5.230	0.190	7.13	88.1	.06	.14	20	.03	.43	.01
			✓		3.490	0.820	11.69	93.9	.25	.43	16	.11	2.92	.01
				✓	2.370	0.130	3.67	93.9	.25	.43	16	.11	.92	.04
Other	✓				2.80	0.10	3.80	-						
		✓			5.875	0.57	11.575	-						
			✓		4.08	0.41	8.18	-						
				✓	1.75	0.07	2.45	-						
Totals					156.62	17.238	329						296.49	99.85

$*F = F_d + 10F_n$

For example, from the example given as Eq. (14) (or from Table A-17), the confidence interval for the Site 2 DNL estimate based on all days DNL's corrected for total aircraft volume is +1.4, -2.1 dB. In addition, from Table A-15, the standard deviation for the average difference between Site 1 and Site 2 is 0.5 dB. Table A-15 also derives the nominal extrapolated DNL value for Site 1 which is 72.7 + 3 = 75.7 dB. Therefore, the confidence limits for the Site 1 DNL estimate is

$$\text{Confidence limits} = 75.7 \pm 1.64 \sqrt{\left(\frac{1.4 + 2.1}{2(1.64)}\right)^2 + (0.5)^2} \qquad (19)$$

$$= 77.6/73.8 \text{ dB}$$

The confidence interval is $\pm$ 1.9 dB. The extrapolated average day DNL estimates with associated confidence intervals for all satellite sites are summarized in Table A-17.

Unfortunately, this calculation procedure is not rigorously sound for two reasons. First, the confidence intervals for the key site DNL-based estimate was determined using the Student t distribution. Use of Eq. 19 assumes that the confidence interval has an equivalent normal distribution variance. However, the result tends to be conservative, producing a larger variance than the original sample mean variance. Second, using the arithmetic difference is inconsistent. However, computing the variance of the ratio of two random variables (in this case the average acoustic energy at two sites) is extremely difficult. An alternate approach, summing the variances of the estimates of sample averages, would be correct only if the standard deviations are relatively small. Suffice to say that the procedure used produces credible values.

OTHER ERROR SOURCES AND OVERALL CONFIDENCE INTERVALS

In addition to the variability within sets of measured data, other factors contribute to the uncertainty in the final result. The factors and the estimated values are as follows:

Factors	Type Error	Value, dB
Temperature-thrust	Uncorrected bias	0.7
Temperature-humidity absorption	Uncorrected bias	0.4
Instrumentation	Uncertainty	0.2
Field Test	Uncertainty	0.5
Root sum square total		0.97

The temperature and humidity bias errors were identified, evaluated, but not corrected for in the section on Post Test Bias Corrections. These uncorrected bias errors are simply squared and added to the variance of the random errors.

The variability of instrumentation errors which vary day to day are already accounted for in the variability in the measured data. Instrumentation errors which do not average out (for example a nighttime sensitivity increase or decrease) add additional uncertainty. This error source is considered small, 0.2 dB.

Finally, aircraft operational factors which are under the pilot's control are usually assumed to be represented faithfully, on the average, during the field test. These factors are power settings, speeds/altitude profiles, and flight tracks. If these factors were indeed representative during the field test, no bias error results from extrapolation of measured noise levels to yearly average day DNL estimates. However, experience has shown that this is not exactly the case. Repeating field measurement programs under apparently identical conditions produces differences in results which are not accountable for by the measurement variability. Based on this somewhat qualitative experience, a value of 0.5 dB was chosen for this factor.

The overall standard deviation of the other error sources (0.97 dB) was combined with confidence intervals obtained from measurement variability (Table A-17), to arrive at "realistic" confidence intervals as follows:

$$\text{Realistic Confidence Interval} = \pm 1.64 \sqrt{\left(\frac{CI}{2(1.64)}\right)^2 + (0.97)^2} \qquad (20)$$

where

CI = confidence interval from measurements.

The "realistic" confidence intervals are listed with the calibrator bias corrected DNL estimates in Table A-19. Inspection of the confidence intervals in Table A-19 shows that statistical accuracy of SEL-derived estimates is better than

Table A-19 Barksdale AFB Yearly DNL Estimates With Realistic Confidence Intervals Based on All Sources of Variability

Data Source	SITE 1		SITE 2		SITE 3		SITE 202		SITE 203		SITE 4	
	Avg	90% CI	Avg	90% CI	Avg	90% CI	Avg	90% CI	Avg	90% CI	Avg	90% CI
All Days Measurements												
No Corrections	-	-	72.0	±3.0	-	-	-	-	-	-	-	-
Corrected for total A/C	-	-	72.7	±2.4	-	-	-	-	-	-	-	-
Corrected for heavy A/C	-	-	72.6	±2.4	-	-	-	-	-	-	-	-
Week Days Measurements												
No Corrections	-	-	73.5	±2.2	-	-	-	-	-	-	-	-
Corrected for total A/C	-	-	73.2	±2.3	-	-	-	-	-	-	-	-
Corrected for heavy A/C	-	-	72.4	±2.6	-	-	-	-	-	-	-	-
SEL Synthesis Measured Data	79.1	±1.6	75.3	±1.6	68.0	±1.6	72.3	±1.6	73.2	±1.6	-	-
Extrapolation from Site 2 DNL	75.7	±2.5	-	-	66.3	±2.6	70.8	±2.6	71.1	±2.5	66.7	±2.6
NOISEMAP (REF)	80.5	-	76.4	-	69.4	-	75.8	-	73.7	-	69.0	-

for DNL-derived estimates but not by as great a margin as indicated in the previous table (which was based only on measurement variability). Another important observation is that the "realistic" confidence intervals do not account for the differences between measured and predicted DNL values.

CRITIQUE OF FIELD MEASUREMENT RESULTS

In the previous section, the average day DNL estimates for all sites at Barksdale AFB were found to be consistently lower than NOISEMAP predictions. In this section, the differences are traced through individual aircraft/operation SEL differences to incorrect NOISEMAP input data. This procedure requires accurate reconstruction of aircraft flight profiles from NOISEMAP chronicles to arrive at a close approximation of NOISEMAP SEL values.

NOISEFILE 1.0 SEL VALUES

Nominal SEL values for most military aircraft have been determined as a function of slant distance. The compilation of these data is called NOISEFILE 1.0. The data are available both in computer tape files and in report form, References 18-23. Listings are presented for takeoff power, cruise power, and approach power for each aircraft. Additional listings are presented for special power settings such as afterburner and water injection. Reference 18 also presents a method for adjusting the SEL values for power settings and speeds which are not identical to the nominal values.

The first step in computing NOISEMAP SEL's was to assemble the SEL listings from References 18-23 for the aircraft at Barksdale AFB as shown in Table A-20. This summary identifies the type of aircraft, the unique aircraft/operation code, the power setting expressed in RPM and/or EPR, and the aircraft speed. Both air-to-ground and ground-to-ground listings are presented.

NOISEMAP AIRCRAFT OPERATIONAL PARAMETERS

The information which is input to NOISEMAP to describe each individual aircraft mission is listed in the NOISEMAP chronicles. The mission frequencies are summarized, but other parameters appear in the order in which the input data package was assembled. The parameters used to reconstruct NOISEMAP SEL values are:

TABLE A-20 NOISEFILE 1.0 SEL SUMMARY (59°F, 70% R.H.)

Air-To-Ground Propagation, Operation/Power Setting: Takeoff

SlntDist.ft.	A/C Type	KC-135A	KC-135A	B-52-G	A-37	T-37	T-38	T-38	T-39	C-130A
	ACC/OPC	026/102	026/103	043/103	504/103	024/103	033/101	033/103	032/103	006/103
	RPM/EPR	96/2.85	96/2.45	94/2.37	100	99	100	100	100	16800/970
	Knots	200	200	170	300	170	300	300	180	170
200		128.6	126.9	129.9	115.2	107.2	123.8	115.1	112.4	98.3
250		127.1	125.6	128.6	113.9	105.0	122.0	113.9	111.1	97.2
315		125.6	124.2	127.4	112.7	104.8	120.1	112.6	109.9	96.1
400		124.2	122.8	126.1	111.3	103.6	118.3	111.3	108.6	94.9
500		122.7	121.4	124.7	110.0	102.2	116.4	109.9	107.3	93.7
630		121.2	120.0	123.3	108.5	100.9	114.6	108.5	105.9	92.4
800		119.8	118.5	121.9	107.0	99.4	112.9	107.0	104.4	91.1
1000		118.2	117.0	120.4	105.4	97.9	111.2	105.4	102.9	89.8
1250		116.6	115.5	118.8	103.7	96.3	109.5	103.6	101.3	88.4
1600		115.0	113.8	117.1	101.9	94.6	107.8	101.8	99.6	86.9
2000		113.2	112.1	115.3	99.9	92.8	106.0	99.9	97.8	85.4
2500		111.4	110.3	113.4	97.8	90.9	104.0	97.8	95.8	83.8
3150		109.4	108.4	111.4	95.6	88.9	102.0	95.6	93.8	82.1
4000		107.3	106.4	109.3	93.2	86.7	99.9	93.2	91.6	80.4
5000		105.0	104.2	107.0	90.6	84.4	97.6	90.6	89.3	78.5
6300		102.6	101.9	104.5	87.9	81.9	95.2	87.9	86.9	76.5
8000		100.0	99.4	101.9	84.9	79.2	92.5	85.0	84.2	74.3
10000		97.2	96.7	99.1	81.8	76.2	89.6	81.8	81.4	72.1
12500		94.1	93.8	96.0	78.4	73.0	86.5	78.4	78.3	69.8
16000		90.9	90.7	92.8	74.7	69.6	83.2	74.8	75.1	67.4
20000		87.4	87.3	89.2	70.9	65.7	79.6	71.0	71.6	65.1
25000		83.6	83.7	85.4	66.8	61.6	75.8	66.9	67.6	62.7

Ground-To-Ground Propagation, Operation/Power Setting:

SIntDist. ft.	A/C Type	KC-135	KC-135	B-52G	A-37	T-37	T-38	T-38	T-39	C-130A
	ACC/OPC	026/102	026/103	043/103	504/103	024/103	033/101	033/103	032/103	006/103
	RPM/EPR	96/2.85	96/2.45	94/2.37	100	99	100	100	100	16800/970
	Knots	200	200	170	300	170	300	300	180	170
200		123.6	121.9	124.9	110.2	102.2	118.8	110.1	107.4	93.3
250		122.1	120.6	123.6	108.9	101.0	117.0	108.9	106.1	92.2
315		120.6	119.2	122.4	107.7	99.8	115.1	107.6	104.9	91.1
400		119.1	117.8	121.1	106.3	98.6	113.3	106.3	103.6	89.9
500		117.7	116.4	119.7	105.0	97.2	111.4	104.9	102.2	88.7
630		116.2	114.9	118.3	103.5	95.9	109.6	103.5	100.8	87.4
800		114.6	113.5	116.8	102.0	94.4	107.9	102.0	99.4	86.1
1000		113.1	111.9	115.3	100.4	92.9	106.2	100.3	97.8	84.7
1250		111.3	110.3	113.7	98.7	91.2	104.4	98.6	96.2	83.2
1600		109.5	108.5	112.0	96.8	89.5	102.6	96.8	94.4	81.6
2000		107.6	106.7	110.1	94.8	87.6	100.7	94.8	92.6	79.9
2500		105.3	104.5	108.1	92.7	85.5	98.6	92.6	90.4	77.9
3150		102.6	102.1	105.8	90.3	83.2	96.2	90.2	88.0	75.6
4000		99.4	99.2	103.1	87.6	80.4	93.5	87.6	85.3	73.0
5000		95.7	95.8	100.0	84.5	77.2	90.2	84.4	82.1	70.0
6300		91.5	92.0	96.5	81.0	73.6	86.6	81.0	78.5	66.7
8000		87.8	88.7	93.3	77.6	70.3	83.3	77.5	75.2	63.7
10000		83.7	85.0	89.7	73.7	66.6	79.6	73.7	71.4	60.4
12500		79.1	80.8	85.7	69.5	62.5	75.4	69.5	67.3	56.8
16000		73.9	76.2	81.3	64.7	57.9	70.7	64.7	62.7	52.7
20000		68.3	71.1	76.4	59.4	52.7	65.4	59.4	57.5	48.5
25000		62.3	65.4	70.8	53.4	46.9	59.5	53.5	51.8	44.2

TABLE A-20 NOISEFILE 1.0 SEL SUMMARY (59°F, 70% R.H.)

Air-To-Ground Propagation, Operation/Power Setting: CRUISE

SlntDist.(ft) A/C Type	KC-135A	B-52-G	A-37	T-37	T-38	T-39				
ACC/OPC	026/104	043/104	504/104	024/104	033/104	033/104				
RPM/EPR	86/1.50	83.5/1.48	90	90	90	89/1.66				
Knots	300	250	300	225	300	250				
200	108.8	113.4	95.9	97.9	95.8	101.8				
250	107.5	112.2	94.8	96.7	94.6	100.7				
315	106.2	110.9	93.6	95.5	93.4	99.4				
400	104.8	109.6	92.3	94.2	92.2	98.2				
500	103.3	108.2	91.0	92.9	90.9	96.9				
630	101.8	106.8	89.7	91.5	89.6	95.5				
800	100.2	105.3	88.3	90.0	88.2	94.0				
1000	98.5	103.7	86.8	88.4	86.7	92.4				
1250	96.8	102.1	85.2	86.8	85.1	90.8				
1600	94.9	100.3	83.6	85.0	83.5	89.0				
2000	93.0	98.5	81.8	83.2	81.7	87.2				
2500	91.0	96.5	79.9	81.3	79.8	85.1				
3150	88.8	94.4	77.9	79.2	77.8	82.9				
4000	86.6	92.2	75.7	76.9	75.6	80.5				
5000	84.2	89.8	73.3	74.6	73.3	78.0				
6300	81.6	87.3	70.8	72.0	70.7	75.3				
8000	78.8	84.7	68.0	69.2	68.0	72.4				
10000	75.8	81.8	65.0	66.2	65.0	69.3				
12500	72.6	78.8	61.8	63.0	61.8	66.1				
16000	69.0	75.6	58.4	59.5	58.4	62.6				
20000	65.2	72.1	54.8	55.7	54.8	59.0				
25000	61.1	68.4	51.0	51.7	51.0	55.1				

Ground-To-Ground Propagation, Operation/Power Setting:

SlntDist.(ft) A/C Type	KC-135A	B-52-G	A-37	T-37	T-38	T-39				
ACC/OPC	026/104	043/104	504/104	024/104	033/104	033/104				
RPM/EPR	86/1.50	83.5/1.48	90/	90/	90/	89/1.66				
Knots	300	250	300	225	300	250				
200	103.8	108.4	90.9	92.9	90.8	96.8				
250	102.5	107.2	89.8	91.7	89.6	95.7				
315	101.2	105.9	88.6	90.5	88.4	94.4				
400	99.8	104.6	87.3	89.2	87.2	93.2				
500	98.3	103.2	86.0	87.9	85.9	91.8				
630	96.8	101.8	84.7	86.5	84.6	90.5				
800	95.2	100.3	83.3	85.0	83.1	89.0				
1000	93.5	98.7	81.8	83.4	81.7	87.4				
1250	91.7	97.0	80.2	81.7	80.1	85.8				
1600	89.8	95.2	78.5	80.0	78.4	84.0				
2000	87.8	93.3	76.7	78.1	76.5	82.1				
2500	85.6	91.2	74.6	76.0	74.5	79.9				
3150	83.1	88.8	72.4	73.7	72.3	77.6				
4000	80.3	86.1	69.8	71.1	69.7	74.9				
5000	77.0	83.0	66.8	68.0	66.7	71.7				
6300	73.3	79.5	63.5	64.6	63.3	68.2				
8000	69.8	76.2	60.1	61.3	60.0	64.7				
10000	66.0	72.5	56.4	57.6	56.4	60.9				
12500	61.7	68.5	52.3	53.5	52.3	56.7				
16000	56.9	64.0	47.6	48.9	47.7	52.0				
20000	51.5	59.0	42.4	43.7	42.6	46.9				
25000	45.4	53.5	36.7	37.9	36.9	41.2				

TABLE A-20 NOISEFILE 1.0 SEL SUMMARY (59^{o}F, 70% R.H.)

Air-To-Ground Propagation, Operation/Power Setting: APPROACH

SlntDist.(ft)	KC-135A	B-52G	A-37	T-37	T-38	T-39	C-130H			
A/C Type	KC-135A	B-52G	A-37	T-37	T-38	T-39	C-130H			
ACC/OPC	026/105	043/105	504/105	024/105	033/105	032/105	006/105			
RPM/EPR	90/1.75	86/1.57	91/	80/	91/	79.5/1.37	4000/580			
Knots	160	140	170	105	170	115	140			
200	115.2	118.0	100.4	103.0	100.3	100.7	96.8			
250	114.0	116.7	99.2	101.8	99.2	99.5	95.6			
315	112.8	115.5	98.0	100.6	98.0	98.3	94.4			
400	111.5	114.2	96.8	99.3	96.8	97.1	93.2			
500	110.2	112.9	95.6	98.0	95.5	95.8	91.9			
630	108.8	111.5	94.3	96.7	94.2	94.5	90.6			
800	107.4	110.1	92.9	95.2	92.9	93.1	89.2			
1000	105.9	108.6	91.5	93.7	91.4	91.6	87.7			
1250	104.4	107.0	90.0	92.2	89.9	90.0	86.2			
1600	102.8	105.4	88.4	90.5	88.3	88.4	84.6			
2000	101.1	103.7	86.7	88.8	86.6	85.6	82.8			
2500	99.3	101.9	84.9	87.0	84.8	84.7	81.0			
3150	97.4	100.0	82.9	85.0	82.9	82.6	79.1			
4000	95.4	97.9	80.9	82.9	80.8	80.5	77.1			
5000	93.2	95.7	78.6	80.7	78.5	78.2	75.0			
6300	90.9	93.4	76.2	78.3	76.1	75.7	72.7			
8000	88.5	90.9	73.6	75.7	73.5	73.1	70.3			
10000	85.8	88.3	70.8	72.9	70.7	70.3	67.8			
12500	83.0	85.4	67.8	69.8	67.8	67.3	65.2			
16000	79.9	82.4	64.7	66.5	64.6	64.1	62.5			
20000	76.6	79.1	61.3	62.8	61.2	60.7	59.8			
25000	73.0	75.7	57.7	58.8	57.6	57.2	57.0			

Ground-To-Ground Propagation, Operation/Power Setting: APPROACH

SlntDist.(ft)	KC-135A	B52-G	A-37	T-37	T-38	T-39	C-130A			
A/C Type	KC-135A	B52-G	A-37	T-37	T-38	T-39	C-130A			
ACC/OPC	026/105	043/105	504/105	024/105	033/105	032/105	006/105			
RPM/EPR	90/1.75	86/1.57	91/	80/	91/	79.5/1.37	4000/580			
Knots	160	140	170	105	170	115	140			
200	110.2	113.0	95.4	98.0	95.3	95.7	91.8			
250	109.0	111.7	94.2	96.8	94.2	94.5	90.6			
315	107.8	110.5	93.0	95.6	93.0	93.3	89.4			
400	106.5	109.2	91.8	94.3	91.8	92.1	88.2			
500	105.2	107.9	90.6	93.0	90.5	90.8	86.9			
630	103.8	106.5	89.3	91.6	89.2	89.5	85.5			
800	102.3	105.0	87.9	90.2	87.8	88.0	84.1			
1000	100.8	103.5	86.4	88.7	86.4	86.5	82.6			
1250	99.3	101.9	84.9	87.1	84.8	84.9	81.0			
1600	97.6	100.2	83.2	85.4	83.2	83.2	79.3			
2000	95.8	98.4	81.5	83.5	81.4	81.4	77.5			
2500	93.8	96.4	79.5	81.4	79.4	79.3	75.5			
3150	91.5	94.1	77.3	79.0	77.2	77.0	73.2			
4000	88.9	91.5	74.7	76.3	74.6	74.3	70.6			
5000	85.8	88.4	71.7	73.0	71.6	71.2	67.5			
6300	82.4	85.0	68.4	69.4	68.2	67.7	64.1			
8000	79.3	81.8	65.2	66.1	65.0	64.4	61.0			
10000	75.9	78.3	61.6	62.4	61.4	60.7	57.4			
12500	72.1	74.3	57.6	58.4	57.5	56.6	53.6			
16000	67.8	70.0	53.1	53.8	53.0	52.1	49.2			
20000	63.1	65.2	48.1	48.7	48.1	47.2	44.5			
25000	57.8	59.8	42.6	42.9	42.6	41.7	39.4			

Flight tracks
Altitude profiles
Delta SEL

Typically, this data will be taken directly from the NOISEMAP chronicles. However, the speed and power setting data used to develop the NOISEMAP inputs were found to be incorrect for the two major aircraft, KC-135A and B52-G. A telephone conversation with Barksdale AFB, Hq. SAC/DEV and AFETO/DEE resulted in the following revised power and airspeeds:

KC-135A	1.50 EPR @ 140 knots	for approach and approach pattern
	1.80 EPR @ 180 knots	for takeoff pattern
	2.20 EPR @ 215 knots	for takeoff for Sites 1, 2, 3
	@ 250 knots	for Site 202
	@ 285 knots	for Site 203
B-52G	1.50 EPR @ 140 knots	for approach and approach pattern
	1.80 EPR @ 180 knots	for takeoff pattern
	2.20 EPR @ 200 knots	for takeoff for Sites 1, 2, 3
	@ 250 knots	for Site 202
	@ 285 knots	for Site 203

Table A-20 gives the nominal SEL values for the various aircraft. Tables A21-A26 give the equivalent NOISEMAP SEL's for the KC-135A and B-52G.

COMPARISON OF MEASURED AND PREDICTED SEL VALUES

In Tables A28-A32 the average measured SEL values, from Table A-12, are with the NOISEMAP SEL values from Tables A21-A27. All five measurement sites to the north of the runway were so evaluated. In Tables A28-A32 the significance of SEL difference is dependent on how much the particular mission contributes to the DNL.

The total DNL values calculated using measured data is within one dB of the calculated values using the NOISEMAP inputs. However, the difference in calculated values for individual procedures was often several dB. These differences are seen for both types of aircraft. The calculated values are consistently lower than the original NOISEMAP values. Up to .3 dB of this difference can be attributed to the fact that only the heavy aircraft were used in the calculations (see Table A-14). The remaining difference probably results from incorrect delta SEL values being used in the original NOISEMAP run.

TABLE A-21 AIRCRAFT OPERATIONAL INFORMATION
STRAIGHT IN APPROACH

KC-135-A

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1	026/105	790	107.5	140 kts	1.5 EPR	-3.9	103.6
2	026/105	1800	101.9	140 kts	1.5 EPR	-3.9	98.0
3	026/105	4600	94.0	140 kts	1.5 EPR	-3.9	90.1
202	026/105	1740	102.7	140 kts	1.5 EPR	-3.9	98.8
203	026/105	1650	102.5	140 kts	1.5 EPR	-3.9	98.6

B-52-G

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1	043/105	790	110.2	140 kts	1.5 EPR	-1.9	108.3
2	043/105	1800	104.5	140 kts	1.5 EPR	-1.9	102.6
3	043/105	4600	96.5	140 kts	1.5 EPR	-1.9	94.6
202	043/105	1740	104.8	140 kts	1.5 EPR	-1.9	102.9
203	043/105	1650	105.1	140 kts	1.5 EPR	-1.9	103.2

TABLE A-22 AIRCRAFT OPERATIONAL INFORMATION
PATTERN APPROACH

KC-135A Mission 23

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1	026.105	790	107.5	140 kts	1.5 EPR	-3.9	103.6
2	026/105	1800	101.9	140 kts	1.5 EPR	-3.9	98.0
3	026/105	4600	94.0	140 kts	1.5 EPR	-3.9	90.1
202	026/105	6600	90.5	140 kts	1.5 EPR	-3.9	86.2
203	026/105	15550(4^o)	67.9	140 kts	1.5 EPR	-3.9	64.0

B-52G Mission 22

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1	043/105	790	110.2	140 kts	1.5 EPR	-1.9	108.2
2	043/105	1800	104.5	140 kts	1.5 EPR	-1.9	102.6
3	043/105	4600	96.5	140 kts	1.5 EPR	-1.9	94.6
202	043/105	6600	93.0	140 kts	1.5 EPR	-1.9	91.1
203	043/105	15550(4^o)	69.9	140 kts	1.5 EPR	-1.9	68.0

TABLE A-23 AIRCRAFT OPERATIONAL INFORMATION
PATTERN APPROACH

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
			KC-135A Missions 31-35				
1	026/105	710	108.1	140 kts	1.5 EPR	-3.9	104.2
2	026/105	1600	102.8	140 kts	1.5 EPR	-3.9	98.9
3	026/105	4500	94.2	140 kts	1.5 EPR	-3.9	90.3
202	026/105	1720	102.2	140 kts	1.5 EPR	-3.9	98.3
203	026/105	1600	102.8	140 kts	1.5 EPR	-3.9	98.9
			B-52G Missions 31-35				
1	043/105	700	110.9	140 kts	1.5 EPR	-1.9	109.2
2	043/105	1750	104.7	140 kts	1.5 EPR	-1.9	102.8
3	043/105	4500	96.7	140 kts	1.5 EPR	-1.9	94.8
202	043/105	1700	104.9	140 kts	1.5 EPR	-1.9	103.0
203	043/105	1700	104.9	140 kts	1.5 EPR	-1.9	103.0

TABLE A-24 AIRCRAFT OPERATIONAL INFORMATIONAL PATTERN TAKEOFF

KC-135A Mission 23

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1	026/103	6900	101.0	180 kts	1.8 EPR	-10.6	90.4
2	026/103	9100	97.9	180 kts	1.8 EPR	-10.6	87.3
3	026/103	12150(6^{o})	88.5	180 kts	1.8 EPR	-10.6	77.9
202	026/103	18000(4^{o})	73.6	180 kts	1.8 EPR	-10.6	63.0
203	026/103	-	-	-	-	-	-

B-52G Mission 22

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1		8600	101.0	180 kts	1.8 EPR	-9.3	91.7
2		10900(6%)	92.1	180 kts	1.8 EPR	-9.3	82.8
3		13500(5%)	87.0	180 kts	1.8 EPR	-9.3	77.7
202		-		-	-	-	-
203		-		-	-	-	-

TABLE A-25 AIRCRAFT OPERATIONAL INFORMATIONAL PATTERN TAKEOFF

KC-135A Missions 31-35

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1	026/103	1750	113.2	180 kts	1.8 EPR	-10.6	102.6
2	026/103	2300	111.0	180 kts	1.8 EPR	-10.6	100.4
3	026/103	4300	105.7	180 kts	1.8 EPR	-10.6	95.1
202	026/103	5300	103.7	180 kts	1.8 EPR	-10.6	93.1
203	026/103	14000	92.5	180 kts	1.8 EPR	-10.6	81.9

B-52G Missions 31-35

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1	43/103	2000	115.3	180 kts	1.8 EPR	-9.3	106.0
2	43/103	3400	110.8	180 kts	1.8 EPR	-9.3	101.5
3	43/103	6000	104.6	180 kts	1.8 EPR	-9.3	95.3
202	43/103	11100	97.7	180 kts	1.8 EPR	-9.3	88.4
203	43/103	21500(4^{o})	74.3	180 kts	1.8 EPR	-9.3	65.0

TABLE A-26 AIRCRAFT OPERATIONAL INFORMATION
STRAIGHT-OUT TAKEOFF

KC-135A Mission 2

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1	26/103	1150	116.1	215	2.2 EPR	-4.6	111.5
2	26/103	2070	111.8	215	2.2 EPR	-4.6	107.2
3	26/103	4680	104.9	215	2.2 EPR	-4.6	100.3
202	26/103	2510	110.3	250	2.2 EPR	-5.3	105.0
203	26/103	3200	108.3	285	2.2 EPR	-5.8	102.5

B-52G Mission 1

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1	213/103	1860	115.9	200	2.2 EPR	-3.4	112.5
2	213/103	2550	113.3	200	2.2 EPR	-3.4	109.9
3	213/103	4900	107.2	200	2.2 EPR	-3.4	103.8
202	213/103	2700	112.7	250	2.2 EPR	-4.4	108.3
203	213/103	3000	111.8	280	2.2 EPR	-4.9	106.9

TABLE A-27 AIRCRAFT OPERATIONAL INFORMATION
STRAIGHT-OUT TAKEOFF

KC-135A Mission 3

Site	Noise Profile	Slant Distance	NOISEFILE (1.0) SEL	Speed	Power Setting	DSEL	NOISEMAP SEL
1	026.103	1075	116.5	215	2.2 EPR	-4.6	111.9
2	026.103	1950	112.2	215	2.2 EPR	-4.6	107.6
3	026/103	5600	105.1	215	2.2 EPR	-4.6	100.5
202	026/103	1850	112.7	250	2.2 EPR	-5.3	107.4
203	026/103	1850	112.7	285	2.2 EPR	-5.8	106.9

TABLE A-28 SYNTHESIS OF SITE DNL VALUES FROM MEASURED AND NOISEMAP SEL VALUES

SITE 1

Type A/C	Mission No.				Frequency			SEL, dB		DNL, dB		
	App		T/O									
	SI	Patrn	Patrn	SO	Day	Night	Equiv. Day, N*	Measured Values (Table 20)	NOISEMAP Values (Fig. 8)	Derived from Measured SEL's	Derived from NOISEMAP SEL's**	Meas. (-) Pred.
KC-135A	10				3.180	0.510	8.28	102.2	103.6	62.0	63.4	-1.4
		23			3.81	1.32	17.01	101.2	103.6	67.7	70.5	-2.8
		31-35			8.602	1.35	22.1	101.2	104.2			
			23		2.54	0.44	6.94	103.8	90.4	67.8	65.0	2.8
			31-35		5.7	0.9	14.7	103.8	102.6			
				2	2.461	0.36	6.06	113.4	111.5	72.5	70.2	2.3
				3	0.41	0.067	1.08	113.4	106.9			
B52G	10				2.910	0.960	12.51	106.5	108.3	68.1	69.9	-1.8
		22			2.07	1.23	14.4	100.7	108.3	67.9	76.0	-8.1
		31-35			7.68	2.37	31.4	100.7	109.0			
			22		1.38	0.820	9.6	106.6	91.7	72.0	69.9	2.1
			31-35		5.1	1.58	20.9	106.6	106.0			
				1	2.436	0.225	4.686	115.3	112.5	72.6	69.8	2.8
DNL Total										78.9	79.8	-.9
NOISEMAP (REF)										80.5	80.5	

*N = Freq.(day)+10xFreq.(night) **DNL = SEL+10logN-49.4

TABLE A-29 SYNTHESIS OF SITE DNL VALUES FROM MEASURED AND NOISEMAP SEL VALUES

SITE 2

Type A/C	Mission No. App SI	App Patrn	T/O Patrn	T/O SO	Frequency Day	Frequency Night	Equiv. Day, N*	SEL, dB Measured Values (Table 20)	SEL, dB NOISEMAP Values (Fig. 8)	DNL, dB Derived from Measured SEL's	DNL, dB Derived from NOISEMAP SEL's**	Meas. (-) Pred.
KC-135A	10				3.180	0.510	8.28	94.1	98.0	53.9	57.8	-3.9
		23			3.81	1.32	17.01	95.9	98.0	62.4	65.0	-2.6
		31-35			8.602	1.35	22.1	95.9	98.9			
			23		2.54	0.44	6.94	98.3	87.3	62.3	62.8	-.5
			31-35		5.7	0.9	14.7	98.3	100.4			
				2	2.461	0.36	6.06	111.2	107.2	70.3	66.4	3.9
				3	0.41	0.067	1.08	111.2	107.6			
B52G	10				2.910	0.960	12.51	96.1	102.6	57.7	64.2	-6.5
		22			2.07	1.23	14.4	96.1	102.6	63.3	70.0	-6.7
		31-35			7.68	2.37	31.4	96.1	102.8			
			22		1.38	0.820	9.6	100.1	82.8	65.5	65.3	.2
			31-35		5.1	1.58	20.9	100.1	101.5			
				1	2.436	0.225	4.686	113.4	109.9	70.7	67.2	3.5
DNL Total										75.1	75.0	.1
NOISEMAP (REF)										76.4	76.4	

*N = Freq.(day)+10xFreq.(night) **DNL = SEL+10logN-49.4

TABLE A-30 SYNTHESIS OF SITE DNL VALUES FROM MEASURED AND NOISEMAP SEL VALUES

SITE 3

Type A/C	Mission No. App SI	App Patrn	T/O Patrn	T/O SO	Frequency Day	Frequency Night	Equiv. Day, N*	SEL, dB Measured Values (Table 20)	SEL, dB NOISEMAP Values (Fig. 8)	DNL, dB Derived from Measured SEL's	DNL, dB Derived from NOISEMAP SEL's**	Meas. (-) Pred.
KC-135A	10				3.180	0.510	8.28	88.6	90.1	48.4	49.9	-1.5
		23			3.81	1.32	17.01	82.9	90.1	49.4	56.7	-7.3
		31-35			8.602	1.35	22.1	82.9	90.3			
			23		2.54	0.44	6.94	87.6	77.9	51.6	57.4	-5.8
			31-35		5.7	0.9	14.7	87.6	95.1			
				2	2.461	0.36	6.06	104.6	100.3	63.7	59.5	4.3
				3	0.41	0.067	1.08	104.6	100.5			
B52G	10				2.910	0.960	12.51	86.6	94.6	48.2	56.2	-8.0
		22			2.07	1.23	14.4	-	94.6	0	62.0	
		31-35			7.68	2.37	31.4	-	94.8			
			22		1.38	0.820	9.6	90.4	77.7	55.8	59.1	-3.3
			31-35		5.1	1.58	20.9	90.4	95.3			
				1	2.436	0.225	4.686	107.1	103.8	64.4	61.1	3.3
DNL Total										67.7	67.8	-.1
NOISEMAP (REF)										69.4	69.4	

*N = Freq.(day)+10xFreq.(night)   **DNL = SEL+10logN-49.4

TABLE A-31 SYNTHESIS OF SITE DNL VALUES FROM MEASURED AND NOISEMAP SEL VALUES

SITE 202

Type A/C	Mission No. App SI	Mission No. App Patrn	Mission No. T/O Patrn	Mission No. T/O SO	Frequency Day	Frequency Night	Frequency Equiv. Day, N*	SEL, dB Measured Values (Table 20)	SEL, dB NOISEMAP Values (Fig. 8)	DNL, dB Derived from Measured SEL's	DNL, dB Derived from NOISEMAP SEL's**	Meas. (-) Pred.
KC-135A	10				3.180	0.510	8.28	92.8	98.8	52.6	58.6	-6.0
		23			3.81	1.32	17.01	92.7	86.2	59.2	62.5	-3.3
		31-35			8.602	1.35	22.1	92.7	98.3			
			23		2.54	0.44	6.94	79.8	63.0	43.8	55.4	-11.5
			31-35		5.7	0.9	14.7	79.8	93.1			
				2	2.461	0.36	6.06	106.8	105.0	65.9	64.6	-1.3
				3	0.41	0.067	1.08	106.8	107.4			
B52G	10				2.910	0.960	12.51	96.2	102.9	57.8	64.5	-6.7
		22			2.07	1.23	14.4	97.2	91.1	64.4	68.7	-4.3
		31-35			7.68	2.37	31.4	97.2	103.0			
			22		1.38	0.820	9.6	92.8	-	58.2	52.2	+6
			31-35		5.1	1.58	20.9	92.8	88.4			
				1	2.436	0.225	4.686	111.5	108.3	68.8	65.6	+3.2
DNL Total										72.2	73.0	-.8
NOISEMAP (REF)										75.8	75.8	

*N = Freq.(day)+10xFreq.(night) **DNL = SEL+10logN-49.4

TABLE A-32 SYNTHESIS OF SITE DNL VALUES FROM MEASURED AND NOISEMAP SEL VALUES

SITE 203

Type A/C	Mission No. App SI	Mission No. App Patrn	Mission No. T/O Patrn	Mission No. T/O SO	Frequency Day	Frequency Night	Frequency Equiv. Day, N*	SEL, dB Measured Values (Table 20)	SEL, dB NOISEMAP Values (Fig. 8)	DNL, dB Derived from Measured SEL's	DNL, dB Derived from NOISEMAP SEL's**	Meas. (-) Pred.
KC-135A	10				3.180	0.510	8.28	98.3	98.6	58.1	58.4	-.3
		23			3.81	1.32	17.01	97.7	64.0	64.2	62.9	1.3
		31-35			8.602	1.35	22.1	97.7	98.9			
			23		2.54	0.44	6.94	-	-		44.2	-
			31-35		5.7	0.9	14.7	-	81.9			
				2	2.461	0.36	6.06	100.4	102.5	59.5	62.6	-3.1
				3	0.41	0.067	1.08	100.4	106.9			
B52G	10				2.910	0.960	12.51	102.7	103.2	64.3	64.8	-.5
		22			2.07	1.23	14.4	102.9	68.0	70.1	68.6	1.5
		31-35			7.68	2.37	31.4	102.9	103.0			
			22		1.38	0.820	9.6	93.5	-	58.9	28.8	-
			31-35		5.1	1.58	20.9	93.5	65.0			
				1	2.436	0.225	4.686	104.7	106.9	62.0	64.2	-2.2
DNL Total										72.9	72.4	.5
NOISEMAP (REF)										73.7	73.7	

*N = Freq.(day)+10xFreq.(night)   **DNL = SEL+10logN-49.4

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